the Petroleum Engineer

FOR MANAGEMENT

11th Annual Report Survey — 63 Companies

Canada's Biggest Year Reviewed

What Is Required of a Manager

INTEGRATED EDITION OF THE PETROLEUM ENGINEER

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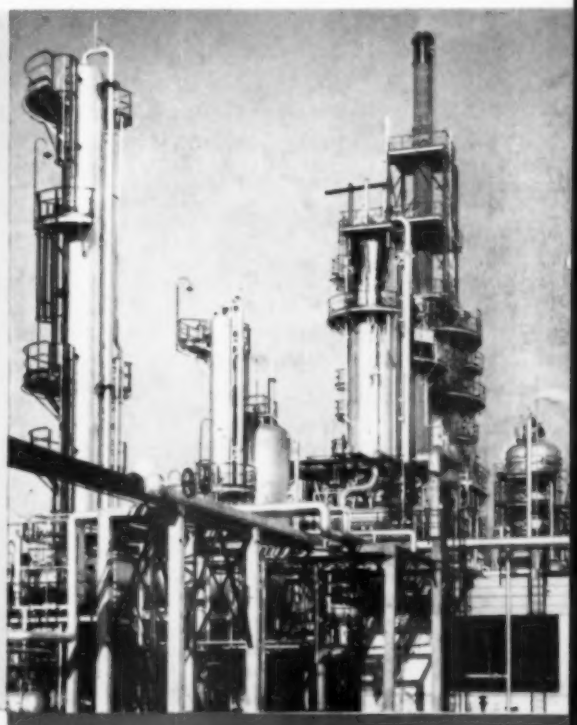

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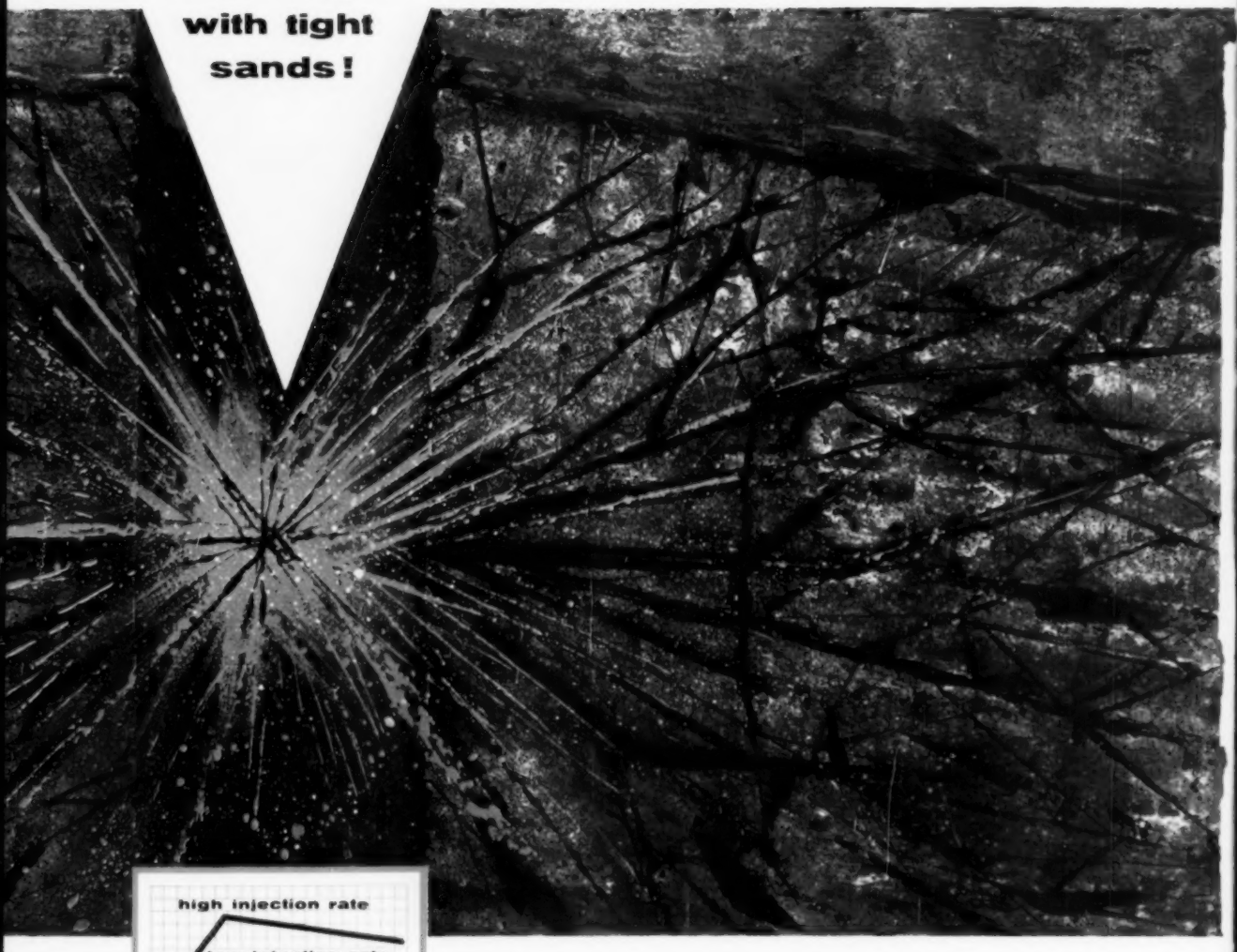
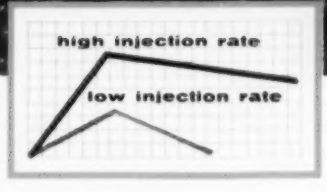
MAY 1957 One Dollar A Copy

Get tough with tight sands!





High injection rates have shown greater production and slower decline.

In most things, gentleness is good and proper.

But not so with some oil and gas reservoirs. To make them *give*, often calls for a "get tough" policy.

Dowell knows how to get tough with tight sands, and has the equipment needed to do it. Exclusive with Dowell is the new high-injection-rate "Frac Team": 1) the mighty Allison Pumper with power to spare, 2) the Remote Panel for safer operation, and 3) the Dowell Blender for precise control of sand and fluid mixing.

More and more, operators are finding that the harder you hit some formations with frac fluid, the greater the production is increased. Two to ten barrel-per-minute rates often provide little more than temporary stimulation. On the other hand, thirty to fifty bpm injection rates into the same formation often establish high and lasting production potentials. Also, with high injection rates, there is less danger of sand screen-outs.

Got a tight sand problem? Dowell will get after it with the experience and equipment they pioneered in high-injection-rate fracturing. Dowell Incorporated, Tulsa 1, Oklahoma.

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— *Ernestine Adams*

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The Biggest Job of All

Can you imagine spending $8 billion so that it would pay for itself and return a profit, provide jobs, meet competition, supply the needs for products? Nobody could do it alone but that is what the U. S. petroleum industry is doing in 1957. In one short year it will spend $8 billion here and abroad for investment in exploration, production, processing, refining, storage, transportation and marketing of oil and gas.

It is the industry's biggest job. The way it is spent – the efficiency of the buyers – means progress or stagnation for the industry. For its consumers it means even more – more and better products or inadequate and inferior supply.

In the past investment in the petroleum industry has paid off in larger reserves, continual upgrading by processing, quicker and cheaper transportation, more convenient buying and better products. We should say here we consider exploration a part of capital expenditure although some accounting systems write off unsuccessful ventures.

Each year the problem of expanding to meet products demands; the problem of understanding to meet political and public opinion demands; and the problem of efficiency to meet stockholder and employee demands put a heavier burden upon management – both administrative and technical.

It is a serious responsibility to invest for profit and there is no industry that invests more than the petroleum industry in simple hope and belief it can make a profit. Public utilities invest more but they are guarded by monopoly franchises and by assurance of a stipulated return. The petroleum industry must venture and accept the results of its venture. Most of the people in it prefer it that way and fight against the controls that would put them under a tent of red tape and directives.

There are probably 25,000 to 30,000 people in the petroleum industry who have a direct influence on how this $8 billion is spent. Most of our readers are among these. You use your background of training and experience for your decisions. You use your study of what others are doing and how their projects worked, as we report them in *The Petroleum Engineer*. You use the research and technical aid that suppliers have always provided. They show what their services and equipment can do in the advertising pages.

You use the economists' figures that give you some idea of what is coming and what the supply and demand picture of the future is expected to be.

You answer scores of questions: Is this the best expansion for the company? Will it eventually pay off to the stockholders and provide for the employees? Should more money go into research? Are we clear on our objectives? Should we increase foreign operations – or should we go into them at all? Should we develop this field or drill on this long-held lease or both?

Facing the industry with the $8 billion – earned, saved, borrowed, or financed some way – is the fact that the world wants more oil and gas products and the industry must be prepared to provide them.

It's in your lap – this biggest job – this tremendous task of investing $8 billion so that it will bring better living in the future. Because you have done so well in the past, our predictions are bright. We predict by 1960 you'll be studying a budget of $10 billion for capital expenditures.

Ernestine Adams.

Congrats and $25 to LOCKWOOD H. POOL, 424 Shell Bldg., New Orleans, La., for this quip.

"..thinks a female connection is a steady date."

The oil country has a whopping big appetite for pipe. Lone Star Steel's huge plant was built for the specific purpose of supplying fully normalized *API casing, tubing and line pipe* to Joe Roughneck, heart of the oil and gas industry. As fast as we can make it, he gets it!

Now . . . we're building again . . . our new stretch-reducing mill and another open hearth furnace. Goal: more fine steel and more pipe . . . to help Joe meet the greater domestic and export demand for petroleum.

Neighbor, wherever you are, specify Lone Star and we both get a good deal.

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"Oilwell's" Triplex Plunger Pumps assure

STEADY SUBSURFACE HYDRAULIC PUMPING

with a minimum of maintenance

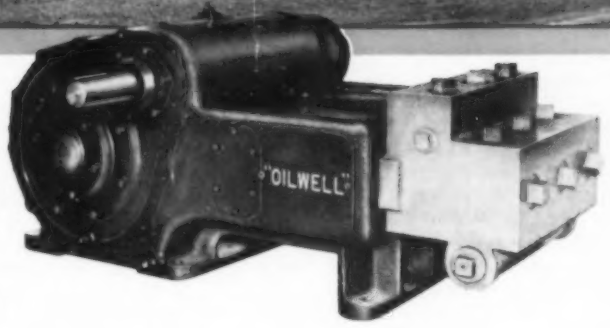
In installations like this, "Oilwell" Triplex Plunger Pumps inject power oil into multiple wells to operate subsurface hydraulic pumps.

324-P and 326-P Triplex Plunger Pumps have proven to be dependable surface units for subsurface hydraulic pumping installations. They can be run at operating pressures for efficient production, yet can develop the very high pressures when it is necessary to dislodge and raise the subsurface pump.

These are rugged, horizontal, three-cylinder, single-acting pumps which can utilize a wide and economical selection of prime movers. Four and six-inch stroke lengths are available to develop the following pressures:

Plunger Size Inches	Maximum Continuous Pressure 4" Stroke	6" Stroke
1⅛	5,000 psi	5,650 psi
1¼	4,080 psi	5,650 psi
1⅜	3,370 psi	5,650 psi
1½	2,800 psi	5,650 psi
1¾	2,100 psi	4,150 psi
2	1,600 psi	3,180 psi
2¼	1,250 psi	2,520 psi

An "Oilwell" Pump Engineer will be glad to give you complete information about the performance of these pumps in subsurface hydraulic pumping operations. Ask for him at your nearest "Oilwell" store.



This 326-P (6" stroke) Pump with forged steel fluid end illustrates the type pump furnished for power-oil injection uses.

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Petroleum Profile

JUST 50 years ago, the Webb City, Missouri, high school basketball team won the Inter-League championship. One of the players was a sinewy lad named W. Alton Jones, and of him the local newspaper observed, "For a youngster he shows marked ability, and with more experience he will become a star in the basketball firmament."

This was not the firmament, however, in which Jones was to seek a shining place. The seventh child in the Jones family, he learned to work early and with the money saved was able to get a start in Vanderbilt University. After one year, he returned as clerk for Webb City & Carterville Gas Company, a unit of the H. L. Doherty public utilities system, which became the foundation of Cities Service Company.

Competition in this league was a lot stiffer than Jones had encountered in scholastic tournaments. Mr. Doherty had surrounded himself with men skilled in finance, engineering, research, and management. There seemed little prospect that an obscure clerk in a small subsidiary could rise far among them, but 14 years later W. Alton Jones was chairman of the company's executive committee, second in command to Mr. Doherty.

He was then only 34 years old and had been attached to the New York staff less than five years. Through the 10 previous years he had moved ahead to become auditor and treasurer of The Empire District Electric Company and Webb City & Carterville Gas Company. He revised the Empire Company's accounting system. He established a simplified method of budgeting. When the survival of the subsidiary hinged on obtaining rate adjustments, Jones was given the job. In two years he appeared at 52 hearings. In every instance he won his case.

In 1920 Jones received a telegram from Frank Frueauff, partner of Doherty and first vice president, inviting him to join the headquarters staff. With Mrs. Jones, the former Nettie Marvin, he said good-bye to Missouri.

The New York job was assistant to Mr. Frueauff and a member of the executive committee. The two men became very close and when, 18 months later, Frueauff died, Jones offered to resign but Mr. Doherty urged him to remain. In 1925 when death took another associate, it was to Jones that Doherty turned.

The program Jones has followed since then tested the endurance of his six-foot, two-inch, farm-hardened body. For years, as first vice president, he was the active director of the company's expanding interests. Mr. Doherty was unable, due to long-continued illness, to perform these duties.

W. ALTON JONES
Chairman of the Board
Cities Service Company

During this time the company went through a period of crisis, compounded of the effects of the general economic collapse of 1929 and the Public Utilities Holding Company Act of 1935. Under this legislation, the company was confronted with the alternatives of confining itself to a single integrated utility operation in a limited area, and disposing of its oil and natural gas operations; or of staying in oil and natural gas and selling its utilities.

For 17 years, Mr. Jones directed a policy of plowing back all earnings and reducing debt while modernizing and expanding the company's physical plant. It was a severe program, but $220 million was lopped off the debt while $450 million was plowed back into expansion and modernization. Choosing to stay in petroleum and natural gas, the company, in the years from 1943 to 1954, sold its public utilities—once proclaimed by a United States senator as worthless — at a corporate profit of more than $100 million.

In 1940, following the death of Mr. Doherty, Mr. Jones had become president. A year later, the United States was at war and he was called on to serve the government in a number of capacities. While continuing the arduous job of rebuilding his company, he carried out many war tasks assigned him, including that of president of War Emergency Pipelines, Inc., which built the great Texas-to-the-East Coast pipelines known as the Big Inch and the Little Inch.

In the post-war era, with his company firmly re-established, Mr. Jones directed an aggressive program of expansion and modernization. Today its total assets exceed one billion dollars. Its petroleum operations, with those of its affiliates, sweep a panorama of the United States, Canada, Central and South America, Egypt and southern Arabia. Its products are marketed throughout the world.

In 1953, the one-time clerk relinquished his post as president and became chairman of the board, continuing as chief executive officer in charge of the supervision and direction of company affairs. When he gets a breather from these duties, he plays a good game of golf, is a more than adequate partner at bridge, and enjoys hunting and fishing. He also takes time off to remember his duties as a grandfather . . . and that seems, among all the roles he is called upon to play, the part in life in which he takes the greatest pride.

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CATERPILLAR TRACTOR CO.

ENGINE POWER CERTIFICATION

This is to certify that the Diesel Engine herein described has been engineered, manufactured and tested in accordance with rigid Caterpillar Standards. The materials and workmanship incorporated into this engine give it the inherent capacity for satisfactory performance when applied in accordance with the power ratings established and recommended by this company. The MAXIMUM OUTPUT capacity of this standard production engine is 200 H.P. @ 2000 R.P.M. equipped with: air cleaner, water pump, lubricating oil pump, fuel pump, and standard intake and exhaust manifolds.

I certify that B. L. Henson, Supervisor of Diesel Engine Test, Caterpillar Tractor Co., signed this Certification and I affix my ... 19 57 ... /58

B. L. Henson
Supervisor Diesel Engine Test
Caterpillar Tractor Co.
Peoria, Illinois

Caterpillar Model D326 Industrial ... was manufactured and shipped as follows: Engine Serial No. 39B1018 Shipping Date February 11, 1957

Power Setting 152 H.P. @ 1600 R.P.M. Intermittent Power Rating

Radiator & Fan	Tachometer Drive
Ether Starting Aid	Muffler
32V Charging Generator	Heater Connections
Governor Control	Remote Shut-off

POWER RATINGS

MAXIMUM OUTPUT is the horsepower capacity of the engine, a measure of the maximum power, 6-5%, that can be developed for five minutes without drop in speed.

INTERMITTENT HORSEPOWER is a rating for use in variable load applications such as excavators, hoists, and standby power units, where the duration of sustained full power output is one hour or less, with the average output not over 85% of Intermittent Horsepower.

RATED HORSEPOWER is a rating for use in applications such as planing mills, hammer mills, and rock crushers where the duration of sustained full power output is 12 hours or less.

CONTINUOUS HORSEPOWER is a rating for use in applications such as work boats and pumps where the duration of sustained full power output is 24 hours per day, day in—day out.

Horsepower figures are established in accordance with rigid Caterpillar standards. All ratings, corrected to sea level barometric pressure (29.92 in. Hg.) and standard temperature (60°F.), apply to a production engine including oil cleaner, water pump, lubricating oil pump, fuel pump and standard intake and exhaust manifolds. The above ratings are based on British and American BHP

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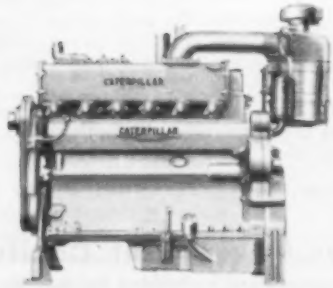
FORM NO. SS3333

In a quarter century of diesel leadership Caterpillar Engines have achieved a reputation for *honestly rated power*. Owners have found that they can depend on a Cat Diesel to deliver the power promised.

Now, to back this reputation, Caterpillar becomes the *first* manufacturer to issue a certificate showing the horsepower capabilities of the engine. This certificate is signed by Caterpillar Tractor Co. and certified by a notary public.

You have a right to demand *certified power* when you invest in an engine. You get it when you buy from your Caterpillar Dealer. Let him show you the certified power plant that fits your needs.

Caterpillar Tractor Co., Peoria, Illinois, U. S. A.



CATERPILLAR*

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THE CONFERENCE TABLE

An ounce of enterprise is worth a pound of privilege – FREDERICK R. MARVIN

Pioneer in Shale Oil

This is the month for our survey of annual reports (See Page A-17.). Many interesting things turn up in the financial and operating reports that oil companies make yearly to their stockholders. This year Union Oil Company of California reported what is probably the first shale oil plant privately owned. It was completed near the end of 1956 near Grand Valley, Colorado, for the purpose of determining if oil can be extracted from oil shale at a cost competitive with crude oil.

The United States government, of course, has done considerable research along this line and Union will benefit from its experience. The program of government research on synthetic liquid fuels began about 1944. During 11 years the program cost the government $87,600,000 and the research, according to the Interior Department, "served the purpose of showing that American oil shales and coal can be processed to liquid fuels and that American equipment can be adapted to and devised for these purposes."

The government's basic research and now the pioneering of private companies, point the way to a new source of fuels that will compete with and supplement petroleum.

No Executive Assembly Line

There is one man who doesn't believe that good executives can be turned out with the ordinary executive development program. He insists they have to be "custom made." This is Joseph Dean Edwards, who wrote very entertainingly of "Executives: Making Them Click,"* and very frankly surveys the new and sometimes clumsy attempts to develop management.

"The myth of today's executive development program is simply the belief that it is a magic formula which properly used, will produce brilliant, effective executives in the precise quantity and at the precise time when they are needed. Good executives can't be mass produced and they shouldn't!"

Edwards states that no program can do magic—that only people can do magic. After pointing out that there is no push-button system that will work if you're interested in developing executives; he analyzes the organizational and human reasons for a man's success or failure in an executive position and shows how you can help people to realize their best potentials.

Good book for both top and middle management people. Edwards advice to top management applies as well to training from level to level.

*University Books, New York; pages, 242; price, $4.

Private vs Government Capital

In our editorial in April we pointed out that the economic investment in foreign countries from U. S. oil companies was better than U. S. government aid. There is also the view that U. S. government aid discourages private capital investment. We have come to this conclusion after studying some of the influence of U. S. aid to Italy.

Right now Italy is feeling a boom perhaps brought on by the $4½ billion which the U. S. has given in economic aid during the last 10 years. The disconcerting thing about this aid is that a great deal of the money has gone to industrial monopolies run by the government. In this way U. S. aid has really developed government-controlled enterprises at the expense of private industry.

This U. S. aid to government enterprises may well have influenced the new petroleum laws which virtually put development of oil and gas into the hands of the government oil monopoly. It is a logical conclusion. We can use our own government agencies as examples. If there has been one that refused to grow and expand and spend more money if it were available, we've never heard of it. Think how much easier then for a government monopoly to grow and expand if the money it uses does not burden its own people with taxes — only the United States taxpayers.

Investments Here and Abroad

It may come as a surprise to you, but there is more foreign investment in the United States than there is U. S. investment in other countries. In recent testimony before the subcommittee on un-American activities Arthur I. Bloomfield, senior economist of Federal Reserve Bank of New York, brought out that foreign investments in the United States at the end of 1954 amounted to $26.8 billion. At the same time, investments of the United States in all industries abroad came to $17.6 billion. Next to manufacturing, petroleum had the highest investment abroad at that time; it was $5.3 billion.

Origin of large sums of foreign capital coming into this country are undisclosed. They are invested in defense industries as well as other American business, and there is evidence of Soviet interests in some of these funds.

Top Annual Report Ads

Each year for 16 years the Financial World has given awards for the best advertisement on annual reports in various industries. Last year the award was presented to Nortex Oil and Gas Corporation of Dallas, Texas, for the petroleum industry. Runnerup for top honors was Ohio Oil Company, and in third place was Pittston Company. "Oscars of Industry" were given in New York in October of 1956 for these 1955 ads on annual reports.

Building Engineers Short Too

It might be interesting to see how another industry deals with engineer shortage. National Constructors Association conducted a survey to see what was being done about shortages of engineers. Results showed:

... 85 percent of the reporting companies indicate they hire high school teachers, college professors or instructors part time.

... 65 percent indicate members of their engineering and technical staffs serve as instructors on a part-time basis for engineering and drafting classes.

... 70 percent provide financial assistance to employees studying engineering or drafting subjects.

... 65 percent provide training of this type in their own organizations.

... 70 percent reported total expenditures in excess of $350,000 per year for educational activities.

Compared to Coal

In the testimony of Walter S. Hallanan, president of Plymouth Oil Company and chairman of the National Petroleum Council, before the committee on interstate and foreign commerce, he compared the recent small increases in oil prices to the increase in coal prices. He said there had been four increases in coal prices in the last three years, with the result that smokeless coal mined in the area where he lives rose from $5.46 a ton in 1954 to $6.96 today. With the scheduled increase of April 1, it went to $7.21.

Mr. Hallanan was not criticizing the increases — he recognized the inflationary basis for the rise. His concern was rather that oil was a captive consumer victim of the upward price spiral.

What Highway Program Will Do

A giant electronic computer has calculated the direct and indirect effects on the national economy of the $50 billion road program financed by the federal government, plus another $50 billion highway construction program expected to be financed locally.

Here are some of the answers given by the computer:

1. The 13-year highway program will generate an average of 880,000 jobs across the 190 industries into which the entire economy was divided.

2. Cement output will rise 28 percent of the 1956 level because of the program.

3. Steel production and tires and tubes will increase 3.2 percent for the program. Total requirements of steel for highways will go up five times; of coke and products over twice.

4. Requirements of crude oil and gas for the whole program (in 1947 dollars) are $141,700,000; of petroleum products $258,300,000; for pipeline transportation, $11,900,000; for gas, $21,000,000.

All this is very interesting, but we are curious as to what will be the additional requirements of the petroleum industry when the effect of the highway construction has passed along to all these industries, and each one spreads the effect upon the industries with which it deals.

This could go on forever, you know, but it is just wheels and circles.

Who's Going to Spend Whose Money?

The whole controversy over the highest peace-time budget in the nation's history is really only a symptom. The real issue is that of government spending vs private spending. It is simply a question of who should spend whose money. Should it be spent by government officials or by the people who earn the money?

On one side are those who feel that the less government spending, the better, and that economic growth is best left in the hands of private business. On the other hand are those who believe that government spending and taxing provides an economic tool with which the government can work toward balanced growth and sound credit for the whole economy.

At the present time about one-fourth of the money earned by individuals and companies is siphoned off by the federal government. This does not even include taxes levied by state and local governments. So you can see, a very large proportion of money earned by companies and individuals is spent by government—by elected and appointed officials.

The actual spending of the money set aside for government projects is such an enormous task that appropriations and collections of taxes have gone far ahead. Figures have not been released on total funds waiting to be spent. Harry B. Hilts, secretary of the Empire State Petroleum Association, pins down the problem for his state. He said, "There is absolutely no financial justification for an increase in New York State's gasoline tax at this time. The great problem facing state officials is not the increasing of road revenues, but the efficient use of the vast amount of funds they have at their disposal."

On the Union Front

The light thrown on the use of union funds by some of those organizations should at least bring extra caution to other union leaders and perhaps a feeling of some responsibility on the part of union members.

It should bring some hesitation, also, to those engineers and scientists who look for a liasion between themselves and management. A man may dodge many responsibilities but not the one to himself.

Secrets of the Earth

British Petroleum Company has published a number of extraordinary booklets on the oil industry, covering particularly areas where the company operates. The latest B-P effort is one of the finest publications we've seen along this line. Called "The Search for Oil," the booklet tells of the methods used in that unending search—a search that often takes man to the remotest regions to wrest from the earth its geological secrets. Maps and diagrams and photographs are in color and in black and white.

The material has been brought down to laymen's understanding without sacrificing comprehensive coverage. It's one of those booklets you want to keep. We don't know how you can get a copy—ours came from J. E. Anderson, who represents British Petroleum in the United States. Office of the company is the Britannic House, Finsbury Circus, London E. C. 2.

Scientific Training in USSR

Early this year David M. Boyd, Jr. (UOP) reported what three Russian educators told him about Russia's "master plan" of education for engineers and scientists.

They said the USSR annually graduates ten times the number of instrumentation and control engineering specialists as are trained in U. S. schools.

The Soviet professors said that all Russian children go to school ten years and are subject to continuous thorough examinations to determine which teenagers go into the army, to factories and farms, or to college.

Those who make the highest grades are paid to go to college, but their courses are selected for them on the basis of previous examinations and tests. The state enrolls four times as many engineers at it needs, and 75 percent are weeded out during the four-year course.

After graduation the state decides who should take graduate studies, teach, or enter industry. Engineers are assigned to a job by the state. Starting wages are high, with inexperienced engineers making five times as much as Russian truck drivers.

There's no teacher shortage, either. Teachers of engineering are paid more than practicing engineers.

HIGHLIGHTS

★ ★ ★

Digest of News and Comment

Oil lift to Europe was "eminently successful," lauds the House Commerce committee's report of findings on its recent oil investigations. The committee indicated that 92 percent of Europe's normal needs in the first quarter of 1957, and in the second quarter, all requirements would be met. "The success of the suddenly enforced alternate operation," said the committee, "cannot but be hailed as a stupendous achievement on the part of the oil industry."

★ ★ ★

Proved reserves of crude, natural gas liquids and natural gas were increased substantially during 1956, reports the American Petroleum Institute and American Gas Association. Combined reports of these two groups showed: Crude oil proved reserves of 30,434 million bbl, up 422 million bbl over 1955 peak; natural gas liquids reserves of 5,902 million bbl, up 464 million bbl, and natural gas reserves of 237 trillion, 774 billion cu ft, up more than 14 trillion cu ft.

★ ★ ★

Natural gas rate control bill of Representative Oren Harris (D.-Ark.) was introduced in Congress and is given a 50-50 chance of survival. Harris indicated that he expected support of the administration from the "President on down." In the Senate, J. P. O'Hara has introduced a companion bill and is expecting the same support. This year's measure includes new provisions that control contract rates, not included in last year's vetoed bill.

★ ★ ★

Oil traffic through the Suez Canal in 1972 is estimated at 335 million tons, as compared with 69 million tons in 1955. Ebasco Services, Inc., made the forecast as part of a survey for the recently ousted canal operator, Suez Canal Company. Survey was begun early in 1956 before the Suez crisis erupted. A Suez company official, commenting on the report, indicated these estimates may be high because of tension in the area and increased use of super-tankers and pipelines.

★ ★ ★

American tanker owners could not compete with foreign ships if they were forced to operate all their ships under the American flag, oil tanker spokesmen told a senate commerce subcommittee, which is studying proposed legislation to bar transfer of tankers from American to other countries. Spokesmen for one tanker company stated that it costs about 51 percent more to carry oil in an American-flag tanker than in a Panamanian-flag tanker, mostly because of crew costs.

★ ★ ★

American Liberty Oil Company transfer of ownership has been completed to American Petrofina, Inc. Transaction involved some $35,000,000 in cash and included the acquisition by Petrofina of all of Amlico's crude oil, condensate and natural gas reserves, undeveloped leases, its Mt. Pleasant, Texas, refinery, pipelines, marketing outlets and various other assets. Amlico was a family-owned company with Toddie Lee Wynne, Sr. as president. Both Amlico and Petrofina are Dallas, Texas-based firms.

★ ★ ★

La Gloria Oil and Gas Com- pany, primarily a gas producer and gas processor, has completed purchase of all stock of McMurrey Refining Company and McMurrey Pipe Line Company. McMurrey, of Tyler, Texas, has one of the most modern, complete independent refineries in the industry. La Gloria, a Corpus Christi-based company, has crude and natural gas liquid production of 17,000 bbl per day, about the crude throughput of McMurrey. La Gloria will not engage in retail marketing.

William G. Skelly, pioneer oilman and philanthropist, died in Tulsa, Oklahoma, on April 11. Skelly, 78, was board chairman of Skelly Oil Company. He has been ill since last fall; death was attributed to a kidney ailment. Skelly was reared in Pennsylvania oil fields and followed the oil booms to Texas, Oklahoma and Kansas in the early 1900's. With the opening of the El Dorado, Kansas, field, he became one of the Mid-Continent area's largest independent operators. In 1917 he organized the Midland Refining Company and later merged it with other holdings into the present Skelly Oil Company.

Navy has been prohibited from exploring for oil in any area that has not been set aside as a Naval Petroleum Reserve by a newly approved House bill. Measure also limits military land and Continental Shelf withdrawals to 5000 acres without prior approval by Congress. In the same legislation, restoration has been made to the Secretary of Interior for jurisdiction and leasing authority in lands withdrawn now or in the future by the Defense Department.

★ ★ ★

Committee on oil productivity capacity of the United States has been named by Walter S. Hallanan, chairman of the National Petroleum Council. A survey of producing capacity up until January 1, by principal producing areas, has been asked by the Department of Interior's oil and gas division. L. F. McCollum, of Continental Oil Company, is chairman. Morgan Davis, Humble Oil & Refining Company, is vice chairman.

★ ★ ★

U. S. and Canadian rig count skidded to a two and one-half year low in the week ending April 8, tabulations by Hughes Tool Company show. Active rig number was 2491, lowest since the 2467 mark set in the week of September 27, 1954, in the wake of the steel strike. Similar week of 1956 showed a rig count of 2806; and in 1955, 2786.

★ ★ ★

"Play now . . . pay later" travel aid plan has been set up by Phillips Petroleum Company as an added attraction to build vacation business. The new plan allows the tourist, or businessman on an extended business trip, to spread once-a-year car expenses over a five-month period. The new service recently offered its credit card holders involves no interest or carrying charges.

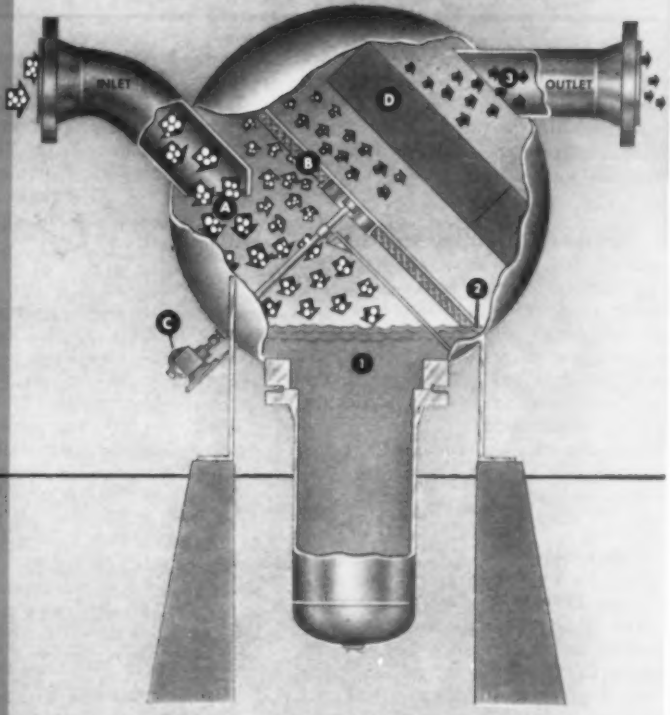
★ ★ ★

Kansas has its first oil and gas production tax in the state's history. Governor George Docking recently signed a bill passed by the state senate levying a one percent tax. The governor, at the same time, indicated that he would not sign a bill increasing the two percent sales tax to two and one-half percent.

MORE EFFICIENT RESULTS!

PEERLESS SCRUBOSPHERE*

*Spherical scrubber for dust and liquid removal from gas flow

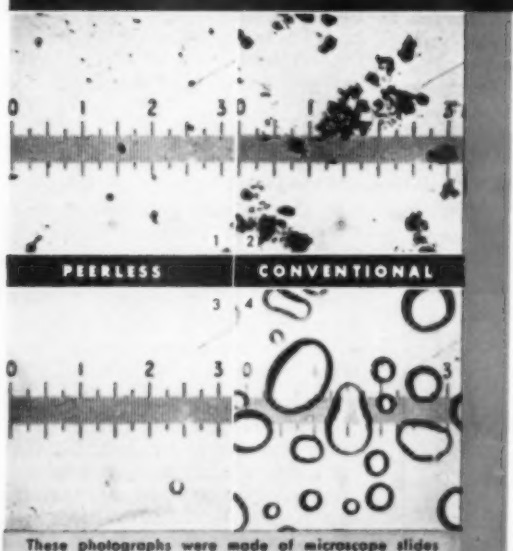


(A) The majority of incoming liquid and solid particles are directed down into reservoir. 1

(B) Lighter solid particles carried by gas stream are separated on surfaces of contactor which are kept wet and clean by revolving through liquid reservoir. 2

(C) Contactor is revolved by explosion-proof gear motor.

(D) Mist Extractor removes any remaining liquid particles from gas stream prior to outlet. 3



These photographs were made of microscope slides introduced downstream of the Scrubosphere and a conventional vertical oil bath cleaner under the same operating conditions. Plates 1 and 2 show the comparative amounts of iron oxide not removed with the amounts introduced being identical. Plates 3 and 4 indicate comparative oil loss with vapor rate through the vessels being the same.

LOOK AT THIS TEST The test at the left indicates the superiority of Peerless Scrubosphere over conventional oil bath dust scrubbers. The SCRUBOSPHERE operates with no loss of efficiency at low flows, minimum liquid loss, and very low pressure drop. Other outstanding features include easy vessel access with removable self-cleaning contactor, a sump for slugs of solid or liquid particles, and minimum cost.

For detailed information write for Bulletin No. 180

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The Second Cuban Petroleum Congress, scheduled for May 5-11, has been postponed, Dr. Alberto Diaz Masvidal, president of the organizing committee, advises. A new date will be announced soon.

★ ★ ★

President Eisenhower has indicated that he will talk to Treasury Secretary Humphrey about U. S. income tax credits received by American oil companies for taxes paid to Mideast nations. A senate subcommittee investigating oil prices brought the tax credit situation to public attention last month. A section of the 1918 tax code allows American companies to deduct income taxes paid to foreign governments before paying U. S. taxes.

★ ★ ★

New natural gas bill introduced by Rep. Oren Harris and Rep. Joseph O'Hara has received general approval by President Eisenhower, who vetoed similar legislation last year because of "lobbying tactics." Speaker Sam Rayburn has said that if the President sticks to his opinion it will meet the demands of the House Democratic leadership. The bill would leave the independent producers under some FPC price control.

★ ★ ★

Oil depletion allowance of 27½ percent not high enough? Treasury Secretary Humphrey has suggested a test for oil depletion that would indicate such a rate might not be enough. Humphrey recently stated that if the present law provides proper stimulus to exploration and keeps crude reserves at a proper level, "then, I would think it would be about right." According to API reports, annual additions to proved reserves have declined.

★ ★ ★

Dependence on the Suez Canal for future oil movements is on the decrease, Felix E. Wormser, assistant Interior secretary told an API Production meeting. "Every effort will be made," he stated, "either by supertankers capable of rounding the Cape of Good Hope economically, or by additional pipelines freer from political interference."

★ ★ ★

"International" status of the proposed Middle East pipeline, as hinted by Secretary Dulles, has met with a flat rejection from Monroe J. Rathbone, Jersey Standard president. He indicated the only government association wanted is recognition of private concerns' right to build and operate the line. Rathbone returned from London talks concerning proposed line designed to bypass Syria. It would be financed on a proportional basis by Jersey Standard, British Petroleum, Royal Dutch-Shell, Compagnie Francais de Petrol, The Texas Company, Gulf Oil, Socony Mobil and Standard of California.

★ ★ ★

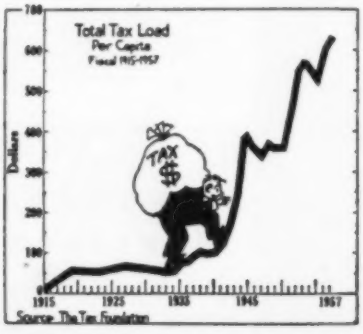
Domestic crude demand could decline to 7,200,000 bbl daily during the second quarter of this year if emergency imports to Western Europe end and seasonal decline for U. S. crude is normal, predicts Independent Petroleum Association of America. IPAA estimates actual crude production averaged about 7,800,000 bbl daily in March and about 7,550,000 bbl per day in April. Domestic consumption in the second quarter, however, is expected to average 3 or 4 percent above the 8,381,000 bbl daily in the same period last year.

★ ★ ★

Kansas Oil and Gas severance tax act has been passed by the state's legislature and signed into law by Governor George Docking. The one percent production tax is expected to net the state $4,200,000 a year. A Kansas house amendment cut the severance tax from two to one percent, as originally planned.

★ ★ ★

Lieut. Gen. Ernest O. Thompson will be honored by southwestern oilmen at the eleventh annual meeting of the Texas Independent Producers and Royalty Owners Association. Thompson, senior member of the Texas Railroad Commission and a leader in oil conservation circles, will get TIPRO's 1957 Recognition Award at the group's May 19-22 meeting.



Not many trends are so decidedly up as the U. S. tax load. Where is that curve going?

Fast tax write-offs totaling $69,000,000 went to help finance construction of new ocean-going tankers in April. The amount exceeded awards made to any other industry under the federal government's rapid tax amortization, production-incentive program. Four tanker companies received the write-offs to aid construction of five vessels. Receiving aid to build additional refining facilities were Phillips Petroleum, Esso Standard, and Socony Mobil.

★ ★ ★

S-11 and H-11, called by Senator Estes Kefauver — a sponsor of the bills — "equality of opportunity" legislation, continues to receive brick-bats from the oil industry. Bills would forbid a supplier from meeting a lower price in a localized area without cutting prices to all dealers everywhere. Concensus of most oil people is summed up by Standard Oil of California's Vice President Howard G. Vesper, who declared the bills would "substitute management by lawsuit for competitive conduct of business under the businessman's right to meet competition in good faith."

★ ★ ★

International Petroleum Exposition dates have been set for May 15-24, 1959. The show, to be held in Tulsa, Oklahoma, is scheduled so visitors attending the fifth World Petroleum Congress in New York City from May 30 to June 6, 1959, may also attend. The exposition also coincides with the 100th anniversary of the Drake well at Titusville, Pennsylvania, in 1859.

★ ★ ★

Utah has been admitted as the twenty-seventh member of the Interstate Oil Compact Commission, Oklahoma Governor Raymond Gary, chairman of the commission, has announced. In a recent statement, Gary said that Utah's Governor George D. Clyde has signed the enabling legislation to conserve oil and gas, a requisite to IOCC membership.

★ ★ ★

Department of Interior is richer by several hundred thousand acres of leases underlying government-grant railroad land. Government fell heir to the mineral rights through a recent Supreme Court decision against Union Pacific. The railroad wanted to drill for oil on its 400-ft wide government-granted right-of-way in Wyoming, but the decision applies to all railroads whose rights-of-way are land grants under a law enacted in 1862.

Good Wells Make Good News

May, 1957

CEALMENT* is a Dowell-developed cementing service that uses a latex-cement slurry. It has provided successful cement jobs under conditions where ordinary cementing often fails. Here are some examples of what this new, exclusive Dowell cementing service has done for others.

- **Alberta, Canada:** An old well in the Joseph Lake Field had declined in production until operator ordered acid treatment. After treatment, well produced 100 per cent water. Cealment was used to perform Bradenhead squeeze, without packer, to shut off water. After multi-stage squeeze, using 40 barrels latex-cement, complete water shut-off was achieved. After drilling out and reperforating, well pumped allowable.

- **Jack County, North Texas** (New Well): Drilled in conglomerate to 5520′. Drill stem tests showed oil at 5450′, water at 5520′. After cementing casing and perforating oil zone, well came in flowing but went to water, revealing channel in cement. Then Dowell was called to squeeze latex-cement through perforations opposite water sand. Result, after reperforating and Mud Acid cleaning, was a 125 BOPD flowing well.

- **Andrews County, West Texas:** An operator in the McFarland Queens field had wells go to water after fracturing. Defective cement jobs were suspected. So, on one well, he used Cealment, tailing in with 500 gallons of latex-cement while setting the 5½″ oil string. This procedure was so successful in solving the water problem that the operator standardized on Cealment to tail in all his oil strings in this field.

- **Calcasieu Parish, Louisiana:** An old well sanded up, indicating the possibility of a hole in the casing. Squeeze testing revealed holes at 4610 and 4624 feet. Cealment was used to patch both holes at the same time. 800 gallons of latex-cement were placed using a squeeze tool above the upper hole. After drilling out, casing was tested to 1200 psi and no leaks were found.

Though the cases presented here deal primarily with remedial work, operators are also finding Cealment has many advantages over common portland for tailing in long strings and setting liners.

For more information or service, call any of the 165 Dowell offices in the United States and Canada; in Venezuela, contact United Oil Well Service. Or write Dowell Incorporated, Tulsa 1, Oklahoma.

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INDIAN ORCHARD, MASSACHUSETTS

Companies Advance on Broad Front

- **Revenues Up 14%**
- **Net Income Up 13%**
- **Capital Expenditures Up 30%**
- **Pay and Benefits Up 10%**
- **Stockholders Equity Up 16%**
- **Long Term Debt Up 20%**

Ernestine Adams

INDUSTRY-wide statistics for 1956 can be collected and analyzed from here on — and they will be — but they do not give you the detailed picture of the oil industry you find in annual reports.

Here in intimate glimpses are the achievements, the problems and the hopes for the future of individual companies.

In 1956 the 62 companies whose activities are surveyed here report almost unanimous increases on all fronts — revenues, net income, taxes, net assets, capital expenditures, drilling, production, refinery runs, reserves.

Gross income was up 14 percent in 1956, on top of a 13 percent rise in 1955 over 1954. But profits narrowed to a 13 percent increase after a 17 percent rise in 1955.

Taxes — both direct taxes on the companies operations and excise taxes on products sales — went up again. Governments did much better than stockholders on petroleum company operations.

Outlook for the future was spelled out in expansion plans that showed management people had confidence in a growing demand and believed their companies could meet it.

Capital expenditures in 1956 rose 30 percent over 1955. They were $2 billion more than total earnings and $3 billion more than total chargeoffs for taxes for the 62 companies.

There is no better indication of industry trends than in company reports to their stockholders. Like other years, the 1956 reports gave insights into what is coming as well as what has already been accomplished.

Miss Adams is Management Editor.

Stockholders

This year there was a greater awareness of the stockholder — that owner of a share of the company. The messages from officers seemed to keep that individual more in mind as they told what the company encountered in 1956, why the management had decided the course it took, what it planned for the future. Here is one beginning:

"To you, the 137,381 stockholders of Standard Oil Company of California, we welcome this opportunity to report on the company's activities."

Quaker State informed its stockholders that their number had more than doubled during the last five years.

Stockholders have always been important people and some companies have realized this but now reports show a more significant recognition of this fact. Jersey Standard moved up to fourth in the nation in number of stockholders. The company now has more than 400,000 (see graph). The petroleum industry itself probably has more share owners than any other. Stockholders are friends and often customers. They can share problems as well as dividends if they understand them.

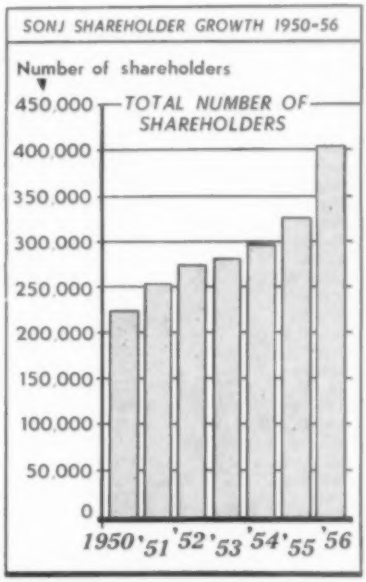
Management

This year marked, too, a more explicit description of management's responsibilities and how they were being met.

As the Husky report said ". . . We have continuously sought capable management personnel, being convinced that a company can grow no faster than its management."

Socony Mobil stated: "A primary objective of the management is to keep the company in a position to respond quickly to changes in conditions affecting its business and earning power," and again, to do this "we must look a long way down the road."

Atlantic Refining told of its management seminar organized and presented by American Management Association for 52 top executives. "This was a pioneering project," the report stated, "and represented another step in our efforts to build and maintain a favor-



Petroleum companies in general have more stockholders than ever before. Jersey Standard gained 79,000 new shareholders last year, due some, of course, to its 3-for-1 stock split. The graph shows how its number of shareholders has increased.

1956 Compared to 1955 for 62 Companies

- **Gross Income Up 14%**
- **Net Income Up 13%**
- **Direct Taxes Up 5%**
- **Excise Taxes Up 16%**

TABLE 1. FINANCIAL STATISTICS OF 62 U. S. PETROLEUM COMPANIES FOR 1956

	Income				Taxes			Per common share**				
Company	Gross ($1000)	% of 1955	Net ($1000)	% of 1955	Direct $1000[a] 1955	Direct $1000[a] 1956	Collected for govts* ($1000)	Common stock[10] 1000 sh	Price 12-31-56	Net income	Direct taxes	Dividends
Amerada	107,859	106	26,499	104	9,304			6,309	$118½	$4.20	$1.50	$2.00
Am. Petrofina	15,520		570			394		5,019	14			
Anderson Prichard	67,788	111	5,880‡	118	1,474	2,148		1,642	37⅛	3.41	1.31	1.15
Argo Oil	12,240	107	4,509	102	1,132	1,028		2,000	32¼	2.27	0.21	1.30
Ashland O & R[1]	279,950	114	13,504	134	11,826	16,184	38,953	5,553	17⅛	2.13	2.91	0.90
Atlantic	544,865	106	47,157	120	22,402	26,808	78,652	8,970	44⅛	5.11	2.99	2.00
Bishop	2,820	119	437	82	128	151		562	13	.78	0.27	0.25s
British American	279,178	103	25,134	122	26,782	18,934		10,097	45⅝	1.36	1.88	1.00
Champlin O & R[7]	67,526	121	9,479	135	1,900	1,500		4,014	26¼	2.28	0.37	0.50s
Cities Service	983,932	105	62,152	126	45,640	49,938		10,313	67½	6.03	4.84	2.40s
Colorado O. & G.	29,382	129	2,682	197				2,985	17⅛	0.70		none
Continental	581,529	109	51,817	112	22,418	29,102	62,600	9,777	126½	5.30	2.98	3.05
Cosden[2]	55,613	111	4,998	141	2,431	3,379		1,088	21¼	4.59	3.11	0.62½
Crescent	1,901		524		0	7		1,391	14¼	0.38	0.05	0.25
Delhi-Taylor	60,039	114	2,043	124	870	1,094		5,271	14½	0.39	0.21	none
Douglas Calif.[3]	23,835	114	237	117	0	35		1,151	5	0.14½	0.30	none
Drilling & Exp.	11,719	102	561	67	67	67		1,896	10	0.30	0.04	0.25
General American[4]	24,017	103	8,735	114	1,765	1,697		2,856	35⅛	1.52	0.30	0.30s
General Crude	12,966	101	3,094	88	1,213	1,139	210	1,886	40⅛	1.64	0.60	1.00
Gulf Oil	2,339,715	123	282,658	130	146,145	154,579	386,579	29,543	123⅞	9.54	5.23	2.50s
Hancock[5]	51,984	122	7,080	116	743	740	9,194	3,367	39½	2.02	0.23	0.60s
Honolulu	42,968	118	13,816	101	4,178	4,924		3,751	68½	3.68	1.31	1.70
Humble[6]	1,012,081	112	178,961	102	84,092	79,715		36,000	125	4.99	2.21	2.40
Husky[4]	30,680	130	2,071	289	834	681		2,926	11½	0.60½	0.23	none
Kerr-McGee[4]	90,441	199	4,680	188	929	1,900		1,812	60¼	2.16	1.05	0.75
Louisiana Ld. & Exp.	26,812	107	14,649	109	8,732	9,071		8,953	60	1.64	1.01	1.30
Macmillan	14,155	103	164	241	120	285	880	1,040	4½	0.16	0.27	non
Midwest Oil	16,465	114	6,559	109	2,097	2,073		2,552	32½	2.57	0.81	1.05s
Monterey Oil[5]	18,204	119	1,453	114	932	1,051		1,806	31½	0.80	0.58	0.80
Nortex Oil & Gas	1,978	155	28	18	25	57		377	9⅛	0.07	0.15	None
Ohio Oil	278,004	107	41,216	100	20,666	19,624		13,127	41⅜	3.14	1.49	1.60
Phillips	1,038,815	114	95,203	100	62,243	54,916	112,000	34,343	53¼	2.77	1.60	1.60
Plymouth	113,500	116	7,955	115	2,958	4,512		2,472	36¼	3.22	1.83	1.60s
Pure	489,884	100	36,560	104	24,043	23,038		8,584	43⅛	4.26	2.68	1.60
Quaker State	52,354	104	1,975	75	3,446	2,745	5,966	927	29¼	2.39	2.96	2.00
Richfield	254,043	104	26,574	90	26,911	24,300	58,886	4,000	67½	6.64	6.08	3.50
Seaboard	47,147	110	9,369	111	900	200		3,733	65¼	2.56	0.53	1.00
Shamrock[6]	52,519	122	9,007	116	4,031	4,107		2,299	52	3.92	1.79	2.00
Shell	1,644,417	110	135,848	108	116,715	114,372	256,192	30,286	90	4.49	3.78	2.00s
Signal	59,197	114	10,694	111	3,516	2,577	6,990	4,097	47	2.61	0.62	0.70s
Sinclair	1,180,101	106	91,071	113	59,854	71,860	203,000	15,222	61½	6.17	4.72	3.00
Skelly	253,592	108	34,093	106	17,942	19,248	25,627	5,746	70½	5.93	3.35	1.80
Socony Mobil	2,793,685	112	249,504	120	150,810	161,399	298,000	43,798	55	5.70	3.69	2.30s
South Penn	61,157	110	6,028	129	5,021	4,998	5,325	1,598	38	3.77	3.13	2.75
Standard Calif.	1,567,348	114	267,891	116	107,585	119,105	193,460	63,224	49½	4.24	1.88	1.65s
Standard Ind.	1,912,000	105	149,430†	101	92,913	89,131	326,779	35,381	62⅛	4.33	2.52	2.31
Standard N. J.	7,281,883	114	808,535	114	544,400	570,000	506,900	196,939	58¼	4.11	2.89	2.10
Standard Ohio	365,687	108	26,592	116	23,097	24,440	70,698	4,820	57	5.35	5.07	2.37½
Sun Oil	733,823	111	56,160	116	36,687	46,985	155,107	10,845	77	5.22	4.33	1.00s
Sunray Mid-Con.	335,759	111	45,310	115	26,163	26,438		17,317	25⅛	2.40	1.53	1.20s
Superior[5]	90,205	112	5,041	148	5,599	6,223		422	1,220	11.94	14.75	none
Texas Co.	2,177,351	115	302,263	115	123,929	142,577	378,209	55,250	59⅜	5.51	2.60	2.35
Texas Gulf	16,732	104	5,658	90	1,651	1,747		3,873	38¼	1.46	0.45	0.60s
Texas-Pacific C. & O.	29,939	103	7,210	91	2,225	2,410		3,596	37⅛	2.01	0.67	1.00
Tidewater	522,556	109	37,990	101	16,791	17,137	72,198	12,059	37	3.15	1.42	5⅞s
TXL Oil[6]	9,370	131	3,716	124	1,802	1,578		5,574	26⅛	0.67	0.28	none
Union Calif.	401,518	109	34,241	112	13,414	14,830	74,120	7,700	59⅜	4.45	1.93	2.40
Union O. & G. of La.	28,366	115	3,316	107	1,210	1,194		1,814	69½	1.83	0.66	0.80
Universal Consolidated	7,596	135	3,355	146	1,003	1,305		959	55	3.50	1.36	2.60
Utah Southern	3,804	121	1,201	114	431	418		1,200	13⅜	0.30	1.00	0.50
White Eagle[1]	12,246	92	742	279	9	none		1,499	14⅛	0.49	none	10⅞s
Wilcox	8,611	104	783	80	251	242		285	55¼	2.75	0.85	1.00
Woodley	6,026	135	2,233	163	273	313		765	79½	2.92	0.41	0.50s
TOTALS	**$29,594,815**	**114**	**$3,159,214**	**113**	**$1,829,643**	**$1,927,840**			**$4,106¼**	**$196.23**	**$123.84**	**$80.01**

[s]Also stock or stock splits.
[x]Also extrn.
**Note — adjustments have been made for stock dividends and splits.
*From customer — taxes on sales in U. S.
[1]Fiscal year ends September 30.
[2]Fiscal year ends April 30.
[3]Fiscal years ends March 31.
[4]Fiscal year ends June 30.
[5]Fiscal year ends August 31.
[6]Fiscal year ends November 30.
[7]Former by merger of The Chicago Corp. and Champlin Refining Co.
[8]80% held by Standard N. J. deducted from totals.
[9]Not including payroll taxes.
[10]Issued.
†Not including a nonrecurring item of $9,235,000 in 1955.
‡Not including a nonrecurring item of $1,562,000.

1956 Compared to 1955 for 62 Companies

- **Capital Expenditures Up 30%**
- **Stockholders Equity Up 16%**
- **Long Term Debt Up 20%**
- **Net Fixed Assets Up 14%**

TABLE 2. CAPITAL ASSETS, CAPITAL EXPENDITURES, AND CHARGE-OFFS OF 62 COMPANIES

Company	Years in business	Gross fixed assets $1000	Net fixed assets $1000	Other assets $1000	Working capital end 1956 $1000	Long term debt $1000	Total stockholders equity (net book value) $1000 12-31-56	1956 Depreciation, depletion, amortization	Capital expenditures $1000 1955	1956	1957 est.
Amerada	36	369,246	82,046	3,656	46,967	none	128,972	12,852	44,475	49,350	
American Petrofina	1	29,717	14,872	276	39,430	13,379	41,200	1,489		New Co.	
Anderson Prichard	35	90,979	51,328	23,513	10,919	9,300	55,383	5,292	9,211	15,004	15,250
Argo Oil	—	43,956	22,683	2,031	2,011	none	26,725	3,959	3,909	4,400	
Ashland[1]	33	184,682	81,053	10,403	46,128	27,721	110,080	14,577	13,494	25,004	20,100
Atlantic	86	870,509	478,560	40,708	123,498	147,500	466,714	46,999	60,117	117,100	
Bishop	30	11,682	7,029	867	(301)	1,521	5,458	793	2,834	2,557	
British American	50	391,647	242,875	18,227	55,993	30,730	286,365	25,727	37,240	62,277[6]	114,000
Champlin Oil & Ref.	—	159,900	79,177	3,784	14,292	37,947	59,306	8,315	21,326	18,389	—
Cities Service	47	1,195,637	673,033	37,513	379,868	459,375	581,501	72,258	114,705	117,011	
Colorado O & G	5	53,950	38,453	700	8,528	16,087	31,761	3,509	9,423	17,001	
Continental	80	828,381	308,494	48,331	106,753	109,276	352,441	77,204	100,603	100,303	110,000
Cosden[2]	20	31,096	20,628	514	5,097	5,195	21,044	1,778	3,000	5,953	
Crescent	38	10,842	9,541	2,966	6,374	732	18,794	658	2,882	3,489	
Delhi-Taylor	11	66,613	41,838	439	13,680	50,133	18,092	4,737		7,500	11,000
Douglas Calif.[3]	27	7,896	3,799	1,043	2,160	1,329	5,673	668	908	1,000	
Drilling & Exp.	28	26,408	13,341	257	3,470	1,250	15,888	2,183	—	3,128	—
General American[4]	20	76,407	46,300	3,900	10,273	235	58,364	7,563	2,076	1,875	
General Crude	27	41,257	23,516	none	9,928	none	33,444	2,261	2,076	6,208	
Gulf Oil	56	3,495,998	1,726,746	267,041	393,788	302,577	2,872,270	217,185	274,480[5]	465,950[5]	
Hancock[4]	34	26,523	12,766	9,579	27,499	none	49,843	1,459	5,407	7,966	
Honolulu	47	123,795	61,815	20,390	13,203	1,469	75,248	7,159	15,300	15,568	
Humble[11]	40	1,960,102	1,166,761	17,982	99,699	27,064	1,258,000	88,668	210,400	183,908	
Husky Oil[1]	18	29,421	20,255	2,063	6,309	15,926	7,559	2,166	9,849	7,256	
Kerr-McGee[4]	25	71,100	50,799	2,007	20,047	36,848	37,203	5,031	13,219	17,790	15,000
Louisiana Ld. & Exp.	—	26,580	19,429	100	3,768	none	23,402	733	3,350	4,125	
Macmillan	34	3,874	1,399	3,088	1,588	104	2,976	2,475	207	182	—
Midwest Oil	45	73,928	26,387	8,042	4,686	none	31,164	2,067	4,314	5,800	
Monterey[5]	6	89,078	73,408	1,065	6,819	35,750	45,542	5,466	3,000	4,700	5,900
Nortex Oil & Gas	3	5,322	4,819	772	1,626	1,433	2,897	354	2,208	3,303	—
Ohio Oil	69	548,983	239,556	12,490	73,807	none	335,525	24,457	39,049	52,440	
Phillips	39	1,668,900	1,016,487	29,234	173,750	243,447	942,288	111,942	184,445	257,352	215,000
Plymouth	33	105,525	55,776	1,643	17,225	18,949	54,832	5,037	9,119	12,164	—
Pure Oil	43	612,577	317,591	9,432	105,986	86,041	452,886	27,907	64,000	58,000	49,000
Quaker State	27	36,935	14,363	917	9,040	250	24,532	1,967	1,246	2,047	
Richfield	45	395,338	199,813	14,244	73,125	78,000	209,183	23,960	43,388	42,428	
Seaboard	38	151,017	61,921	1,752	10,954	none	75,843	14,025	9,727	2,387	
Shamrock[10]	28	82,052	54,950	330	10,428	24,900	40,808	4,011[12]	13,030	9,738	11,600
Shell Oil	44	2,230,652	750,907	38,968	287,253	197,408	903,054	208,172	271,347	234,646	
Signal O & G	34	142,713	78,540	15,193	11,814	18,992	82,062	7,066	13,900	27,600	
Sinclair	41	1,528,812	884,307	106,888	311,976	355,169	925,062	74,902	165,625	180,341	160,000[9]
Skelly Oil	37	494,607	240,888	5,558	59,730	6,327	298,703	30,783	47,746	43,966	
Socony Mobil	74	2,923,748	1,521,203	282,388	590,352	211,418	2,074,152	200,269	266,369	329,000	475,000
South Penn	67	119,898	20,706	4,757	26,069	none	48,910	4,883	2,053	6,354	
Standard Calif.	78	2,569,434	1,394,070	64,859	308,584	76,721	1,690,792	145,557	346,638	361,100	400,000
Standard Ind.	68	2,872,517	1,677,135	63,724	460,190	298,864	1,900,000	156,063	229,900	291,900	350,300
Standard N. J.	75	7,374,494	4,355,137	401,237	1,650,180	584,996	5,111,442	388,258	861,520	1,082,804	1,250,000
Standard Ohio	87	402,777	212,950	7,715	54,019	28,000	246,684	23,309	47,522	50,110	83,200
Sun Oil	56	726,405	398,494	4,535	98,096	11,019	493,195	84,993[7]	106,500[7]	114,700[7]	
Sunray Mid-Con.	37	692,554	357,666	6,909	83,245	58,711	396,949	45,737	53,232	65,917	78,000
Superior[3]	36	219,623	137,488	25,705	21,962	81,857	110,424	9,390	23,900		
Texas Co.	55	2,857,951	1,435,467	182,216	598,547	363,855	1,849,974	189,900	283,091	502,614	
Texas Gulf	26	58,997	26,951	2,919	6,808	6,450	35,324	2,912	8,907	9,660	11,500
Texas Pacific	68	85,360	50,707	none	6,471	none	57,177	5,416	10,460	8,920	
Tidewater	78	849,106	464,176	18,553	124,431	200,000	413,761	40,214	129,970	193,891	93,000
TXL OIL[10]	2	19,139	16,370	none	4,050	none	20,569	1,748			
Union of Calif.	67	825,854	400,766	27,180	158,527	189,865	391,006	61,411	87,969	85,285	87,000
Union O & G Louisiana	62	72,433	34,992	282	8,037	10,095	29,342	4,237[7]	9,411	10,926	—
Universal Consolidated	34	10,267	2,809	38	9,049	none	30,154	316	525	500	500
Utah Southern	—	3,373	2,632	52	726	none	4,134	1,294	579	—	—
White Eagle[1]	37	26,207	13,122	878	3,453	8,650	8,589	2,243	2,851	3,626	3,200
Wilcox	39	14,324	5,288	575	2,432	none	8,640	488	1,135	1,263	
Woodley	34	21,282	14,358	4,387	1,127	5,600	12,768	829	3,441	2,395	
TOTALS	—	$39,572,297	$20,852,408	$1,819,066	$6,729,904	$4,439,546	$24,933,391	$2,361,101	$4,127,675	$5,352,634	—

[1] Fiscal year ends Sept. 30
[2] Fiscal year ends April 30
[3] Fiscal year ends March 31
[4] Fiscal year ends June 30
[5] Fiscal year ends Aug. 31
[6] Excludes all property acquired from Gulf with book value of $62,431,000.
[7] Includes intangible development costs.
[8] Exclusive of extraordinary acquisitions and acquisition of possible concessions in Venezuela.
[9] Excludes amortization of undeveloped leases.
[10] Fiscal year ends Nov. 30.
[11] 80% owned by Jersey Standard excluded from totals.
[12] Depletion and depreciation.

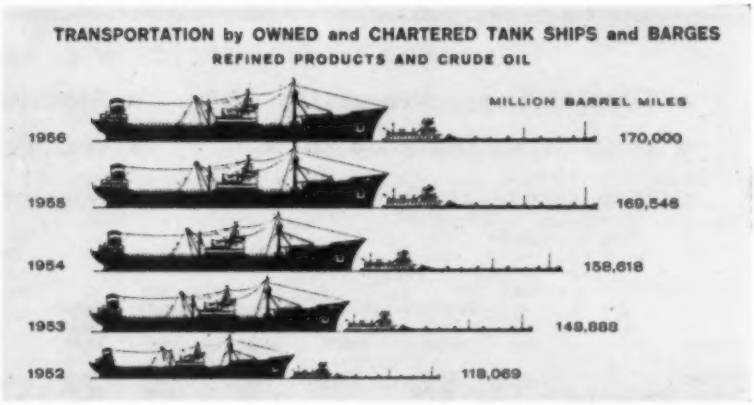
able climate for the development of our management talent."

And Sinclair's message: "In my opinion the chief executive of a far-flung enterprise faces no task more vital than that of providing for continuity of management comprising the highest quality talent that can be developed or obtained."

Stockholders of White Eagle were told: "Following almost four years of intensive searching we have accomplished our objective of building an outstanding management team."

Gulf explained its decentralization program as a requirement for improved managerial tools, the purpose to diffuse responsibility "so that decisions may be made in the field to the maximum extent and competence of the entire personnel improved by exercise of positive action. . ."

Management at last was explaining the importance of managers. The stockholders could learn that finding and developing top people was also a job — perhaps a bigger job than to find and develop an oil or gas field.



Sinclair's report pictured ownership of an expanding fleet of tankers and barges. Suez crisis stimulated shipbuilding.

Mining

Another trend that shows up in annual reports of 1956 is the ventures into other resources — uranium and oil shale. Petroleum companies have always had to look far ahead. An oil discovery takes years to bring to efficient production, and transportation lines must be arranged or constructed.

Now they are looking into a future where uranium and oil shale and tar sands provide some needed energy and they are getting ready for it.

Colorado Oil and Gas formed a subsidiary, COG Minerals Corporation, to operate uranium mines as "the company considers that uranium, an energy raw material, is a natural complement to its oil and gas activities."

The Texas Company's 50-percent owned Texas-Zinc Minerals Corporation acquired one of the largest uranium mines in Utah and began construction of an ore processing mill.

Kerr-McGee is operating a uranium mill at Shiprock, New Mexico, and plans another in the Lake Ambrosia area (see map.)

Utah Southern had acquired uranium prospects in Utah, Colorado and Arizona.

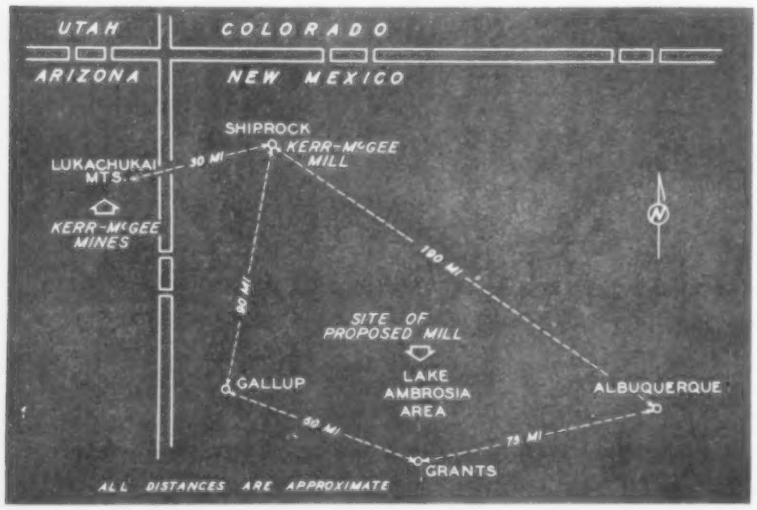
Possibilities of oil shale are getting attention. Union Oil of California reports its shale oil plant near Grand Valley, Colorado, has begun testing. This is the first one built by private enterprise. Other companies are getting leases in the shale oil areas.

Richfield Oil has acquired reservations in Alberta, Canada, covering over a million acres of land in the Athabasca tar sand area.

Foreign Operations

There is a continuing trend in foreign operations among all U. S. firms in 1956. You can see by checking the asterisks before company names in Table 3 that about three-fourths of our list have operations in foreign lands.

Taken from Kerr-McGee annual report is this map of a proposed uranium mill site. Mining is attracting many companies.



Despite setbacks, projects go determinely ahead.

"The Spanish explorations continue with negative results, but prospects deemed inviting, as a result of gravity meter, geophysical and geological investigations, remain to be explored. Projected work in that country continues to absorb a reasonable allocation of the Company's exploration funds. The rewards of success in this undertaking, if attained, are vast and warrant its continued participation" reads the General American report.

Amerada states: "Geological and geophysical expenditures are again expected to be somewhat larger, due mainly to an anticipated increase in exploratory activities in foreign countries."

Superior Oil reported $22,103,000 paid for an undeveloped oil and gas concession in Lake Maracaibo in Venezuela.

A Signal Oil and Gas subsidiary was awarded the first concession ever granted by the government of Guatemala. It has interests in others there, and rights in Venezuela, Iran, Kuwait-Saudi Arabia Neutral Zone and Canada.

You notice that all these are "independents."

Seaboard may be right. Its report stated: "The increasing difficulty in finding oil in the United States has caused many companies . . . to extend their activities in foreign countries. Seaboard's first major effort was in the Province of Alberta, Canada . . . More recently, in association with others, Seaboard's activities have been extended to Venezuela and Turkey, where exploration work is actively being pursued."

Research

Another continued trend is the steady increase of interest and greater expenditures for research.

Reports Get Better Year by Year

YOU don't have to be a mathematical genius or a CPA to read an annual report any more. Oil company reports never were as obtruse as some financial presentations we have seen but 11 years ago a great deal of information was skipped.

There is a new awareness of the stockholder for whom the report is written. Stockholders are growing in numbers and in variety and some companies really want to sell him and keep him sold. He supplies the capital, usually gives moral support, buys your products if he can. He or she (women own more stock than men) is a pretty important person and it is good to see that each year more annual reports are directed to stockholders instead of at them.

Some items that attracted our attention in annual reports are mentioned below. We didn't attempt to review all the good points; only a few highlights of interest.

In the **Sunray-Mid-Continent** report more than half a page is devoted to public relations—something that other reports have not mentioned. This describes what Sunray has done to further its relations with its employees, shareholders, customers, dealers, suppliers, communities, and the general public.

Only company to include taxes per share of capital stock outstanding in its 10-year summary was **The Texas Company.** It also includes state, federal, and Canadian motor fuel and oil taxes. This is vital information if the shareholder is to learn the company's burden in taxes.

Tidewater uses a four-page insert to give the facts about its great Delaware refinery, the largest ever built at one time with capacity of 130,000 bbl a day.

A clear five-year table of capital expenditures including 1957 estimates is given in the **Ashland Oil and Refining** report. Each year's investments, including the estimate, is broken down into different branches.

Phillips Petroleum lists its managers of various departments as well as directors and officers — emphasizing importance of management personnel.

In the **Colorado Oil and Gas** report the comparative highlights give success ratio of development wells and of exploratory wells. The number of net wells and the amount of footage is also shown, each divided into development and exploratory.

Anderson-Prichard carries the percentage change of 1956 financial and operating figures compared to 1955. This gives a quick but satisfactory picture of progress.

Bishop Oil's report has one of the tables, seen in several reports this year, on sources and disposition of funds. It is easily grasped by the layman.

Humble Oil and Refining presents excellent expenditure data, including average drilling costs per well, cost of leases, exploration expenditures charged against current income, cost of research, etc.

The first report of **Champlin Oil and Refining** since it was formed (merger of The Chicago Corporation and Champlin Refining Company) helps to orient the stockholder with comprehensive statistical material, including exploration and capital expenditures.

Texas Pacific Coal and Oil devotes virtually its entire 24-page report to tables, giving the most detailed table in any report covered on its leases and production.

General American gave an excellent review of the engineering side of its drilling and producing program. The story on the deepening of Wheeler No. 1 was an oilfield thriller.

Standard of Ohio puts the stockholders up front. After a brief financial review tables are given of stockholder classification, shares held, etc. Sohio also gives in its 10-year table the number and total salaries of officers and directors earning more than $30,000 a year.

One of the best things you'll read in any report is "Sun's Creed." It states: "We of **Sun Oil Company** wish to set forth the principles which guide us in the conduct of our business affairs."

Very few give proposed capital expenditures for 1957 as did **Texas Gulf Producing.** The report also gives a breakdown of what the expenditures will be used for.

Union Oil of California has a remarkable picture of its shale oil plant near Grand Valley, Colorado, on the cover of its report. The plant was completed near the end of 1956.

British American made effective use of graphs to show how its reserves and production had jumped with the acquisition of Canadian Gulf Oil Company in 1956.

The quote on the inside cover of **Cosden Petroleum** set the tone of its report. "The secret of success is constancy to purpose". . . Disraeli.

Douglas of California had an interesting story of its Peruvian joint venture. It looked as if the company had to write off the investment. Then an offset well came in with good production, so work began again. Another example of ups and downs of the oil business.

Seaboard has a simple and understandable explanation of a change in accounting practice. This year was the first time that intangible development costs have been 50 percent capitalized by the company and amortized over a 10-year period. Comparison figures show the effect of the new system.

Skelly Oil has a comparison for six years of its balance sheets in a slightly condensed form. This makes a very complete financial picture.

South Penn Oil had the most complete breakdown of employees of all annual reports covered. It went into detail showing employees on payroll, in armed forces, retired, insured, deceased, beneficiaries, compensation, etc.

The comprehensive report of **Standard Oil of California** features an excellent review of financial and operating statistics for 10 years. Western and Eastern hemisphere figures are given separately and also total world-wide figures.

Considering that **Louisiana Land and Exploration** is a royalty company, its annual report gives a full and detailed account of its properties—very interesting to those who know something about the industry.

Monterey made effective use of an antique map of New Spain (Southwest U.S.) on its cover and repeated it on the pages dealing with its exploration program. Inside cover has an explanation of the 16th Century map.

"A company of people . . . a record of progress," is the head that **Ohio Oil** uses to keep the personal touch in its 69th annual report.

Pure Oil's map in the center of its annual report is simple and comprehensive. It shows everything from research laboratories to ocean and inland water routes.

In its five-year summary **Quaker State Oil Refining** has a good comparison between taxes on income and net income. Over the five-year period federal, state, and foreign income taxes have run about the same as the net income of the company.

"The importance of a coordinated and adequate research program in an integrated organization such as ours cannot be over-emphasized. This is recognized in all phases of the Company's operations, and carefully considered effort is directed to this activity." Thus states the Shell report.

Suez and Imports

Special prize problem of the year was the blockage of the Suez and destruction of pumping stations on the Iraq Petroleum pipeline.

There were many shades of opinion on the effect of the crisis.

"Seizure and blocking of the Suez Canal has brought a new realization of the importance of the Middle East to the Western World," declared The Texas Company.

"The Suez crisis merely delayed the date for taking firm and positive action to control the volume of imports . . . The United States . . . cannot and must not rely upon foreign oil," emphasized Anderson-Prichard.

One direct effect of the Suez blockade was the strong market for tankers. Tidewater Oil reported: "In making commitments for 12 additional tankers in 1956, the Company more than doubled its tanker construction program, which now totals 21 supertankers ranging in size from 46,000 to 68,000 deadweight tons."

Costs and Price

"The most serious problem with which our industry is faced, as is the nation, is that of endeavoring to control the creeping inflation."

That was Pure Oil's view of the industry's top question at issue in 1956.

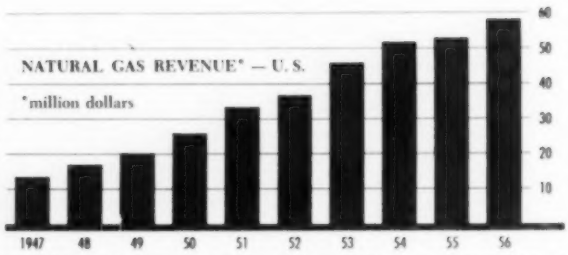
Bishop Oil report put it succinctly: "Costs of operation in the oil industry have been rising faster than the income received for products sold.

Stated Humble: "Income did not increase as rapidly as investment in 1956, pointing up the decline in profit margins that has occurred in domestic operations because of rising costs."

The general advance in price for crude oil and related refined products increases came in January of 1957, too late to have any effect on 1956 income.

Although gross and net income took a steady upward path, costs narrowed the margin of profit in 1956. Argo report says that "from June, 1953, until January, 1957, constantly recurring increases in costs of labor and materials had not been offset by corresponding increases in the price of crude oil and gas."

Standard Indiana felt the same way about products: "Gasoline prices did not support the heavy increases in wages and other costs and very expensive improvements in octane numbers and other quality factors."



Phillips' report showed increase in gas sales, told of developing markets for intrastate gas.

Woodley Petroleum observed that the price increases were vital to improve national reserves and indicated that further price advances may still be expected.

"The important thing about this crude price increase is that it will give us more money with which to look for oil," was Texas Pacific Coal and Oil's opinion.

Union Oil and Gas of Louisiana had these comparisons of prices:

	December, average price	
	1956	1955
Crude oil and condensate per bbl	$2.85	$2.88
Gas liquids per bbl	1.94	2.02
Natural gas per Mcf	0.09	0.09

At least for this company 1956 showed price weakness. Standard Ohio expressed the concern of many about holding the rise in early 1957: "It remains to be seen whether demand will sustain the new price levels . . . after the normal flow of Middle East crude is restored."

Plymouth denies one premise of coming price weakness — that gasoline stocks are too high. "Even though our stock of gasoline at the end of January (1957) was 13 million barrels greater than at the end of January 1956, this higher volume represents two less days of supply," reported Plymouth and called for expansion of storage capacity.

Federal Control

Besides costs top problem of 1956 was the Federal control of natural gas producers.

Continental report said, "One of the most vexatious current problems of the petroleum industry is that of freeing natural gas producers from utility-type regulations by the Federal Power Commission. The interests of gas consumers can best be protected by permitting the field prices of gas to be governed by the free interplay of competitive and economic forces."

Although Delhi-Taylor had an increase in sales, its report pointed out, "An even larger increase in natural gas sales might have resulted if the 'Harris-Fulbright' Bill had been allowed to become law and would have freed independent producers of natural gas from Federal jurisdiction."

Stated Champlin Oil and Refining: "Since present regulation is proving costly and unduly time-consuming to independent producers of natural gas, it is hoped that the Congress will act favorably on legislation."

Phillips Petroleum showed a 11 percent increase in revenue (see graph) and a 4 percent rise in natural gas output but more than 40 percent of the increase was used by the company in its own operations. Phillips described to stockholders its continued efforts to attract industry to gas-producing states and to stimulate growth of other intrastate gas markets.

Shamrock, which emphasizes gas processing, hoped for legislation to relieve producers of "such stringent regulations and of the necessity of . . . receiving approval of gas prices. . ."

Percentage Depletion

A perennial problem is the percentage depletion controversy. Although the 27½ percent formula has been accepted for 30 years, there seems to be always political reasons for criticizing it. As Sunray Mid-Continent report says, "the industry must still defend this just measure to protect ourselves sufficiently so that we can continue to supply the people of the nation, including our critics, with the benefits of petroleum—now and in the future."

In view of South Penn Oil: "The Suez situation points up the need of encouragement to these producers, from the viewpoint of national defense, to further explore for oil and gas within the United States. Under this circum-

TABLE 4. Income for First Quarter 1957.[1]

Company	Gross income ($1000) 1957	Gross income ($1000) % of 1956	Net income ($1000) 1957	Net income ($1000) % of 1956
Atlantic Ref.	—	—	14,761	121
Champlin O & R.	20,793	111	3,107	132
Continental	155,378	107	13,640	99
General Amer.[3]	12,082	101	3,993	92
Gulf Oil	—	—	94,938	132
Kerr-McGee[4]	110,700	122	6,500	139
Shell	—	—	41,450	118
Socony Mobil	—	—	70,000	113
Sun Oil	—	—	—	109
Sunray Mid-Con	90,000	111	11,083	118
Superior[2]	25,626	122	4,335	414
Texas Co.	—	—	86,424	124
Texas Pacific	6,595	107	2,068	101
Wilcox Oil	2,764	102	254	85

[1]Quarter ending March 31.
[2]Quarter ending Nov. 30.
[3]Estimate for year ending June 30.
[4]Six months ending Dec. 31.

1956 Compared to 1955 for 62 Companies

- **Production Up 9%**
- **Refining Runs Up 9%**

TABLE 3. OIL AND GAS OPERATIONS — 1956

Company	Net lease or fee dev. or undev., 1000 acres	Net wells drilled 1956	Net Producers		Wild-cats, net	Dis-cover-ies, net	Net pro-ducing wells owned	Net Production		Refineries Owned		Estimated Reserves	
			Oil	Gas				Crude oil & LPG b/d[3]	Gas MMCF/d[3]	Crude oil capacity b/d[3]	Crude runs b/d[3]	Oil, million bbl.	Gas, billion C.F.
*Amerada	13,037[15]	427[1]	270	48	—	—	3,185	89,816	—	—	—	593	2,000
*Anderson Prichard	648	157	108	4	23	6	988	13,031	41	30,000	29,360	—	—
Argo Oil Corp	681	71[1]	40	—	—	—	322[1]	12,450	—	—	—	90	160
*Ashland O & R	—	106	54	—	37	5	—	9,051	—	165,500	124,057	11	—
*Atlantic Refining	7,358	305	192	39	—	—	4,698	109,226	478	210,000	205,782	543	3,200
*Bishop Oil	73	10	308	—	—	—	308	3,358	—	—	—	8	—
*British American	13,500[17]	—	—	—	—	—	—	44,674	—	95,700	94,521	430	3,654
Champlin O & R	1,313	156	101	12	37	7	—	22,871	257	29,000	—	28	1,520
*Cities Service	7,671	—	392(O&G)		—	—	—	120,937	818	275,600	259,000	—	—
*Colorado O & G	1,314	73	47	12	16	6	—	7,257	42	20,000	14,039	—	—
*Continental	8,178[2]	595	415	29	116	25	7,094[13]	165,974	373	143,150	140,974	—	—
Cosden Petroleum	134	68	48	—	—	—	—	2,791	—	—	27,130	20	19
*Crescent Corp.	92	17	2	—	—	—	90	1,452	—	—	—	15	10
*Delhi-Taylor	612[4]	41	15	15	16	—	—	4,822	92	55,000	39,178	18	2,250
*Douglas of Calif.	—	—	—	—	—	—	41	1,011	—	—	16,994	2	—
*Drilling & Exp.	—	27[15]	24	—	—	—	—	3,896	—	—	—	11	20
*General American	256	43[2]	39	—	—	—	2,801	22,475	—	—	—	114	246
General Crude	956	68	18	1	50	4	308	10,969	—	—	—	94	150
*Gulf Oil	—	1,655	—	—	230[2]	72[2]	—	962,889	—	—	667,806	17,708	8,200
Honolulu Oil	2,469	126	97	11	20	8	1,396	39,330	55	none	—	—	—
Humble O & R	15,701[5]	905	692(O&G)		152	48	13,145	405,500	1,065[7]	282,600	261,800	—	—
*Husky Oil	392	—	—	—	—	—	252	6,332	—	6,500	5,854	—	—
*Kerr-McGee	1,137	—	—	—	—	—	—	6,550	82	—	34,235	16	833
Louisiana Ld. & Exp.	702	—	—	—	—	—	—	19,438	31	—	—	100	1,000
Macmillan	255	—	—	—	—	—	14	160	—	11,500	10,250	—	—
Midwest Oil	341	59	38	3	17	5	855	15,042	35	none	—	82	260
Monterey Oil	254	19	10	1	6	1	646	21,037	37	—	—	61[13]	141
Nortex Oil & Gas	26	94[1]	38[1]	3[1]	4[1]	3[1]	142[1]	717	1	—	—	6	8
*Ohio Oil	55,545	498[4]	373	32	56	14	7,788	108,355	282	46,500	42,421	654	2,300
*Phillips Petroleum[2]	10,410	509	375	27	62	18	8,332	207,558	1,778[7]	257,200	244,765	961	13,200
*Plymouth Oil	595[2]	95	81	1	—	—	1,284[1]	20,005	89	—	39,610	90	700
*Pure Oil	4,905	250	129	18	54	17	—	67,271	277	197,300	163,890	460	3,750
Quaker State	48	150	119	—	—	—	—	1,914	—	—	7,703	—	—
*Richfield	905	122	61	5	—	—	1,330	62,339[20]	—	129,500	121,527	—	—
*Seaboard	—	—	—	—	—	—	—	42,180	100	—	—	205	700
Shamrock O & G	645	147	107	9	46	21	886	13,988[14]	197	—	16,567	28	1,700
*Shell Oil	21,995	—	—	—	—	—	—	304,000[20]	1,027	579,000	498,000	—	—
*Signal O & G	—	77[16]	58(O&G)		—	—	1,150	54,500	—	—	—	260	200
*Sinclair	10,183	532	377	27	100	17	—	166,528	335	488,000	447,823	857	2,525
Skelly Oil	4,948	411	247	65	—	—	4,781	71,497	354	—	46,258	351	2,300
*Socony Mobil	11,521[2]	902[2]	678[2]	84[2]	66[2]	—	15,906[2]	603,928[20]	949[2]	812,000	858,957	8,504	9,660[2]
South Penn Oil	721	208[5]	101	—	—	—	13,448	10,049	8[7]	12,000	9,917	44	59
*Standard Calif.	46,101[11]	973[6]	759[6]	52[6]	116[6]	32[6]	9,336	754,120[12]	494	520,500[11]	753,162	13,620	4,000
*Standard Ind.	26,195	824	549	103	144	46	12,424	294,855	1,154	703,500	642,343	2,140	12,230
*Standard N. J.	231,667	2,041	1,384	153	541	216	27,620	2,020,000	—	2,605,000	2,449,000	—	—
*Standard Ohio[17]	2,041	115	54	8	42	7	2,099	34,940	109	138,000	140,125	90	632
*Sun Oil Co.	12,340	543	340	55	190	94	—	122,233	462	270,000	259,750	744	3,707
*Sunray Mid-Con.	5,729	424	247	49	140	37	5,239	88,158	342	120,000	106,129	424	2,000
*Superior Oil	—	316	245(O&G)		—	—	—	68,560	221	—	—	—	—
*Texas Co.	36,337	1,461[2]	1,080[2]	89[2]	—	—	—	634,489	933	616,000[2]	709,150	14,105	9,500
*Texas Gulf	219	47	—	—	—	—	365	13,500	—	—	—	105	350
*Texas Pacific	1,635	78	57	—	—	—	—	20,769	35	—	—	—	—
*Tidewater	2,805	236	199	—	32	10	5,771	100,538	294[7]	—	178,724	560	2,451
TXL Oil Corp.	1,973	60	55	—	4	2	81[9]	2,652	—	—	—	—	—
*Union Oil of Calif.	3,189	260	181	11	76	25	3,697	109,743	182	194,900	168,000	533	2,183
*Union O & G of La.	759	47	29	12	6	4	—	11,585	190	—	—	—	—
Universal Consol.	26	17	15	0	2	0	288	7,417	8	—	—	—	—
Utah Southern	—	27	13	—	—	—	—	4,768	—	—	—	—	—
*White Eagle	258	55[1]	41[1]	3[1]	14[1]	9[1]	479	3,261	19	—	—	18	315
Wilcox	182	35	21	—	—	—	371	2,645	—	—	—	—	—
*Woodley	1,414	33	25	—	6	2	453	7,155	6	—	—	—	—
TOTALS	—	—	—	—	—	—	—	7,834,056	—	—	9,636,286	—	—

*Has foreign operations.
[1]Gross.
[2]Also part interest in others.
[3]U. S. only.
[4]Calendar day.
[5]Excludes 219 service wells.
[6]Excludes 103 input wells.
[7]Sales.
[8]Undeveloped.
[9]Net working interest wells.
[10]Also 5600 b/d royalty income.
[11]Wholly owned companies in Western Hemisphere only.
[12]Includes interest in Eastern Hemisphere of 388,503.
[13]Also 45 million bbl gas liquids.
[14]9040 b/d LPG.
[15]Gross acreage in Western Hemisphere only.
[16]Also drilled 14 secondary recovery wells.
[17]U. S. and Canada only.
[18]Development only.
[19]Excludes 433 input wells.
[20]Crude oil only.

stance, it is increasingly important that no change be made in the present percentage depletion allowance."

Taxes

Taxes were so prominent, it looked as if the entire operation of the petroleum industry was built primarily to carry them.

Cities Service, reporting on the slight rise in the gasoline prices, reminds its stockholders: "The increase in basic price does not, however, represent the full rise in cost to the consumer. The principal element in the increase in the consumer's cost has been Federal and State taxes, which account for 57 percent of the total increase since 1948."

For our 62 companies, direct taxes increased about $100,000,000 for 1956, which is 5 percent higher than 1955 taxes. Gasoline, lube oil, and other excise taxes advanced about 16 percent.

To bring this down to the average shareholder, suppose you had one share of stock in each of the 62 companies in Table 1. You would have paid $4106.75 for them at the end of 1956.

In the previous year these 62 stocks would have earned $196.23 or 4.8 percent on your investment but your dividends would total only 2 percent of your investment — $80.51, excluding stock splits and dividends, which must prove their value.

For the same period direct taxes paid by the companies amounted to $123.84 for the 62 shares, which is 56 percent more than you received in dividends.

This does not include excise taxes collected by Federal and State governments on sales of specified products.

The petroleum industry carries a back-breaking load on taxes.

Net Return

One curve in the financial picture that persists in pointing downward is the rate of return on net worth or stockholders' equity. Below are percent figures for seven years. First five years are from Petroleum Facts and Figures* and the last two years are from our 62-company survey:

Rate of Return on Net Capital Employed

1950	15.5%
1951	16.8%
1952	14.6%
1953	14.5%
1954	13.0%
1955	13.0%
1956	12.7%

These calculations are average, of course. Cosden Petroleum reported earnings 28 percent of stockholders equity. Gulf reported 14 percent.

This year ratio of profits to sales is virtually the same as last year for the companies surveyed — 9 to 1. That is, $1 is profit on $9 of gross income or about 11 percent return on revenue.

Compared to some industries this is high but the petroleum industry is not comparable in many ways. Its huge investments to find new reserves are highly speculative and the industry must generate much of its capital.

In addition the gross income includes return on investments, such as stock in other companies and royalties, which cost little to handle. TXL and Universal Consolidated, which hold large royalties, made $1 profit in less than $3 gross income.

Operations

As you can observe from Table 3 compared to Table 2 in last year's urvey*) all operations increased.

Report after report shows larger roduction, rising refinery runs, inreased reserves.

Then there are the operations from ver-expanding diversification.

Monterey reports natural gasoline lants accounted for 20 percent of its ash income.

Ashland explains that one of the basic strengths of the company is its ownership of transportation facilities including 3518 miles of gathering lines.

The growing use of LPG is noted by Skelly, which is keeping pace with the trend by increasing underground and above ground storage to assure customers a dependable supply.

Secondary recovery projects are treated more casually than a few years ago when they first showed up as a significant trend in annual reports. Texas Gulf Producing tells of a pressure maintenance program in the Headlee-Parks Ranch area. Instead of a recovery of 2400 bbl an acre by primary methods, an estimated recovery of 54 percent of the oil in the Devonian reservoir indicates a net recovery of 10,000 bbl an acre.

This year showed a number of companies reporting drilling and production offshore separate from operations inland.

Capital Expenditures

The vital need for capital expenditures that look far into the future, pushed this sum up steeply in 1956. For the 62 companies the total was $5,352,634,000.

This does not include all exploration items. Company accounting is individual in capital investment, including investments made to find new reserves. Not only that but practices change from year to year.

A rough estimate when exploration and producing costs are in one figure is that exploration requires one-third and production two-thirds.

On top of the amazing 30 percent increase in 1956 over 1955, plans in 1957 indicate another 10 percent increase this year for the 62 companies. This is still higher than estimates for industry as a whole. The Commerce Department and SEC report all industry plans to spend about $37.4 billion on new facilities this year compared to $35.1 billion in 1956. This is 6 percent higher than last year, which was 22 percent above 1955.

Sun Oil explains that its report must be evaluated by taking into consideration the huge sums it has invested for rebuilding, modernization and expansion of facilities. In 11 years the company spent some $936 million compared to $422 net earnings.

According to Honolulu Oil, it has expended "a high percentage of its earnings during recent years in exploratory and development operations. It is anticipated that in the year 1957 even greater expenditures will be required for these purposes."

Inflation has had its effect on investment in reserves and facilities. As Jersey Standard reviews it: "The rise in capital outlays is due not only to growing consumer needs but also to higher costs of the things we must buy. For example, it is estimated that the cost of building a 50,000-barrel-a-day refinery on the East Coast of the United States would be 30 percent higher today than it was in 1948. The average oil well drilled in the United States cost $49,000 in 1948 and would now cost $70,000. Moreover, the necessity of having spare capacity ready to meet emergencies imposes additional burdens of expense."

Outlook

"Weighing all pertinent factors, we anticipate an increase in domestic production in 1957 and increased exploratory activities in all known and prospective oil provinces of the Western Hemisphere," as a result of the Middle East situation, Midwest Oil told its stockholders.

Ohio Oil reported "the general economic outlook supports the expectation of a normal increase in the domestic demand for petroleum."

Various estimates ranged from 3½ to 5 percent rise in domestic demand. With exports early in the year to Western Europe, total would probably be still higher.

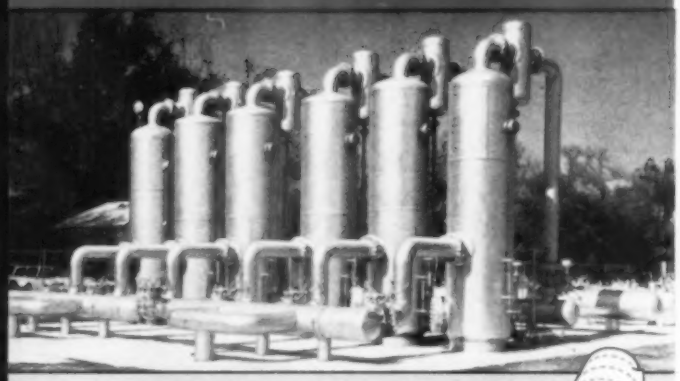
First quarter reports are mostly encouraging, reflecting price increases.

All indications point to another record year in 1957. It appears that revenues, profits and capital expenditures will reach new highs. The industry is tackling its job as if the only curve it knew how to make went up. ★ ★ ★

*Published by API. These figures were compiled by Economics Department, Atlantic Refining Company.

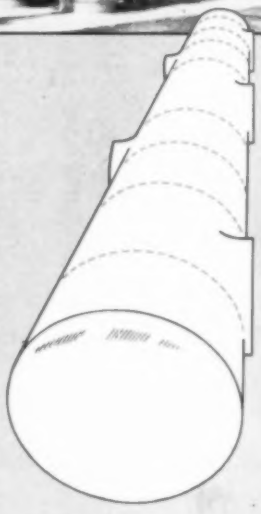
*Company Operations and Sales at All Time High in 1955, by Ernestine Adams, *The Petroleum Engineer*, May, 1956, Page E-2.

How Oklahoma Natural compounded savings by specifying cold extrusion



Oklahoma Natural Gas Company compounded installation savings at their South River Station, Tulsa, by (1) designing for multiple outlet headers and, (2) specifying Fluor-formed headers with cold extruded outlets.

The diagram at the right shows how each of the four 20″ O.D. headers at the South River Station eliminated five 20″ × 20″ × 12″ reducing outlet tees and eight 20″ welds (indicated by broken lines on diagram)—a total saving of 20 tees and 32 welds!



By specifying Fluor-formed headers with cold-extruded nozzle outlets, these added savings were realized

1. IMPROVED STRENGTH & DURABILITY – Polished extrusion dies impart a smooth, dense surface finish to the outlet—assurance of longer service life where vibration or pulsation stresses are involved.

2. CLOSER DIMENSIONAL TOLERANCES – Flowing steel under compression while in a tough stable condition permits extremely close tolerance dimensional configurations—center-to-center and centerline location tolerances are easily held within .060″.

3. LESS MATERIAL NEEDED – Fluor-formed cold extruded multiple outlet headers need no extra length for manufacture—they are made to the exact length and wall thickness required.

4. NO DELAYS – Because nozzle outlets are cold extruded, headers are often made from stock or from the same pipe used elsewhere in a job—production is faster, inspection is simpler.

DIFFICULT JOBS A SPECIALTY

Many difficult design problems can be solved by cold extrusion techniques. Qualified Fluor Products Company engineers are ready to furnish you specialized technical information on how this process can be utilized to save you time and money.

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ASSOCIATES: Fluor Corporation of Canada, Ltd., Toronto; Head-Wrightson Processes, Ltd., London, England.

RISE IN FLUID LEVEL, ETC., DUE TO RUNNING 2½-IN. EXTERNAL-UPSET TUBING IN WELL FLUID

Diameter of outer string or open hole, in.	Internal diameter of outer string or open hole, in.	Volume[1] contained in outer string or open hole		Volume[1] contained in annular space		Volume[1] in well bore when tubing is in hole (volume in annulus plus volume in tubing)		For every 100 ft. of tubing run in fluid, fluid level will be raised:	
		gal.	bbl.	gal.	bbl.	gal.	bbl.	in annular space when lower end of tubing is closed, ft.-in.	in well bor when lower end of tubin is open, ft.-in.
Tubing strings									
Non-upset									
4	3.958	63.92	1.522	29.73	0.708	54.04	1.287	115- 0	18- 3
Upset									
4	3.958	63.92	1.522	29.73	0.708	54.04	1.287	115- 0	18- 3
Casing strings[2]									
4½	4.090	68.25	1.625	34.06	0.811	58.37	1.390	100- 5	16-10
4½	3.920	62.69	1.493	28.50	.679	52.81	1.257	120- 0	18- 8
5	4.560	84.84	2.020	50.65	1.206	74.96	1.785	67- 6	13- 2
5	4.276	74.60	1.776	40.41	0.962	64.72	1.541	84- 7	15- 2
5½	5.044	103.8	2.741	69.61	1.657	93.92	2.236	49- 1	10- 6
5½	4.670	88.98	2.119	54.79	1.305	79.10	1.883	62- 5	12- 5
6	5.524	124.5	2.964	90.31	2.150	114.6	2.729	37-10	8- 7
6	5.240	112.0	2.667	77.81	1.853	102.1	2.431	43-11	9- 8
6⅝	6.135	153.6	3.657	119.4	2.843	143.7	3.421	28- 8	6-10
6⅝	5.675	131.4	3.129	97.21	2.315	121.5	2.893	35- 2	8- 1
7	6.538	174.4	4.152	140.2	3.338	164.5	3.917	24- 5	6- 0
7	5.920	143.0	3.405	108.8	2.590	133.1	3.169	31- 5	7- 5
7⅝	7.125	207.1	4.931	172.9	4.117	197.2	4.695	19- 9	5- 0
7⅝	6.625	179.1	4.624	144.9	3.450	169.2	4.029	23- 7	5-10
8⅝	8.097	267.5	6.369	233.3	5.555	257.6	6.133	14- 8	3-10
8⅝	7.511	230.2	5.481	196.0	4.667	220.3	5.245	17- 5	4- 6
9⅝	9.063	335.1	7.979	300.9	7.164	325.2	7.743	11- 4	3- 0
9⅝	8.535	297.2	7.076	263.0	6.262	287.3	6.840	13- 0	3- 5
10¾	10.192	423.8	10.090	389.6	9.276	413.9	9.855	8- 9	2- 5
10¾	9.760	388.7	9.255	354.5	8.440	378.8	9.019	9- 8	2- 7
11¾	11.150	507.2	12.076	473.0	11.262	497.3	11.840	7- 3	2- 0
11¾	10.772	473.4	11.271	439.2	10.457	463.5	11.036	7- 9	2- 1
13⅜	12.715	659.6	15.705	625.4	14.890	649.7	15.469	5- 6	1- 6
13⅜	12.347	622.0	14.810	587.8	13.995	612.1	14.574	5-10	1- 7
Open hole (bit size)[3]									
3⅞	3.875	61.27	1.459	27.08	0.645	51.39	1.224	126- 3	19-10
4¼	4.250	73.70	1.755	39.51	0.941	63.82	1.520	86- 6	15- 5
4¾	4.750	92.06	2.192	57.87	1.378	82.18	1.957	59- 1	12- 0
5⅝	5.625	131.4	3.129	97.21	2.315	121.5	2.893	35- 2	8- 1
6	6.000	146.9	3.498	112.7	2.683	137.0	3.262	30- 4	7- 2
6⅛	6.125	153.1	3.645	118.9	2.831	143.2	3.410	28- 9	6-10
6½	6.500	172.4	4.105	138.2	3.290	162.5	3.869	24- 9	6- 1
6¾	6.750	185.9	4.426	151.7	3.612	176.0	4.190	22- 6	5- 7
7	7.000	199.9	4.760	165.7	3.945	190.0	4.524	20- 4	5- 2
7⅛[4]	7.500	229.5	5.464	195.3	4.650	219.6	5.229	17- 6	4- 6
7¾[4]	7.750	245.1	5.836	210.9	5.021	235.2	5.600	16- 3	4- 2
8½[4]	8.500	294.8	7.019	260.6	6.205	284.9	6.783	13- 1	3- 5
9¾[4]	9.750	387.9	9.236	353.7	8.421	378.0	9.000	9- 8	2- 7
10⅝	10.625	460.6	10.967	426.4	10.152	450.7	10.731	8- 0	2- 2

The 2½-in. external-upset tubing has a calculated weight of 6.44 lb. per ft. (including a coupling spaced every 20 ft.). The volume displaced by 100 ft. of tubing and 5 couplings: (1) by the steel itself (with end of tubing open), 9.841 gal. or 0.2343 bbl.; (2) by the pipe (with lower end of tubing closed), 34.19 gal. or 0.8140 bbl. The volume contained within 100 ft. of the tubing is 24.31 gal. or 0.5788 bbl.

[1]All volume figures are based on 100 ft. of depth; multiply to convert to other depths or lengths. For example, if the depth or length is 5196 ft., multiply by 51.96.

[2]Only maximum and minimum weights of pipe are shown for each casing size.

[3]Variation in diameter of open hole due to caving, etc., is disregarded.

[4]This diameter is an average of the two bit sizes ⅛ in. larger and smaller, respectively.

Table suggested by George B. Rice, Butler & Horne Drilling Co., Dallas, Texas.

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PHYSICAL CONSTANTS OF HYDROCARBONS

Hydrocarbon	Specific gravity 20/4 °C.	M. P. °C.	B. P. °C.	Index of refraction n_D^{20}	Viscosity Abs. Poises	Spec. heat	Heat of vaporization Cal/G	Heat of combustion K-Cal/mol	Aniline point °C.	Coeff of expansion °C.	Critical constants P Atms.	Critical constants T °C.	Critical constants D	Vapor pressure °C.	Vapor pressure mm.	Octane number Actual	Octane number Blending	Surface tension 20°C. Flash °C.
C_2H_4 Ethylene (ethene)	0.9852 (air); 0.5699 (-103.9)	−169.4	−103.9 (767.5)	1.363 (-100)	0.000093°(g); 0.0000990 (17.1)	0.371(g) (26.8)	118.5	337.28p		0.006894 (-17.8)	50.9	9.8	0.22	−125.2 174.0 −110.0 523.4		>100r 81.0m	85.5r	16.50 (-103.9)
C_3H_6 Propylene (propene)	1.49 (air); 0.5148	−185.2	−47.6	1.3567 (-40)	0.000078°(g); 0.0000840	0.371(g) (26.17)	108.8	491.82p		0.002718 (-17.8 to $+10$)	45.4	91.4	0.233	−85.02 75.7 −60.60 404.6		>100r 85m	102r	16.70 (-47.0)
C_4H_8 1-Butene	1.93 (air); 0.5952	−190	− 6.32	1.3777 (-25)	0.000070°(g); 0.00008194 (0)	0.366(g) (20–140)	93.8	649.66p		0.002052 (20–30)	42.1	160.0		−28.07 300 −16.69 500 − 1.92 900		80m	111.5r	15.9 (-6.1)
2-Butene*	2.004 (air); 0.6300 (1.0)	−127.0	1.0		0.000069°(g); 0.00007964 (0)	0.366(g) (20–140)	96.3	638.2		0.002037 (20–30)	42.1	155.0		−19.2 334.7 − 4.7 609.8		83m		16.7 (1.0)
2-Methyl-propene (isobutene)	2.011 (air); 0.5942	−140.7	− 6.93	1.3796 (-25)	0.000073°(g); 0.00008434 (0)	0.366(g) (20–140)	93.8	647.2p	14.9	0.001954 (20–30)	39.48	144.7	0.234	−28.52 300 −17.19 500 − 2.50 900		87m		15.72 (-6.6)
C_5H_{10} 1-Pentene (amylene)	2.42 (air); 0.6410	−138.0	30.1	1.3710	0.00239 (20)	0.282°	75.0 (12.5)	806.78p	19.0		40.4	201.2				92r	98.5r	
2-Pentene*	2.42 (air); 0.6505	−138.0	36.4	1.3797		0.51516		794.5	18.3		40.4	202.4				98r 80m	125r 107m	16.93
2-Methyl-2-Butene (Trimethyl-ethylene	2.42 (air); 0.6620	−133.6	38.49	1.3869	0.00252°; 0.00230 (10)	0.50816	93.1	795.7p	12.8	0.00158 (15–20)	35.3	191.6		2.5 184.7 18.1 359.1		98r	157r 122m	17.34
C_6H_{12} 1-Hexene	2.902 (air); 0.67337	−141.0	63.7	1.3880	0.002885 (20)	0.499 (22.4)	82.54	963.9p	22.8			243.5		10 90 60 600		80r	85r	17.77
2-Hexene*	0.6813	−149.0	67.9–68.1	1.3928	0.00314 (20)		84.33	962.3p	26.0			243.8		0 50 60 600		89r 78m	100r	18.93
3-Hexene	0.68161 (0)		66.6 67.0	1.3942	0.00335 (20)		84.87	950.8	27.0 (mc)							97r		19.48
2-Methyl-1-Pentene	0.6817		61.5–62.0	1.3921				950.8									69 5m	

See table P 771.001. B for footnotes.

Table from "Physical Constants of the Principal Hydrocarbons," by M. P. Doss, 4th edition, by courtesy of copyright owner, The Texas Company.

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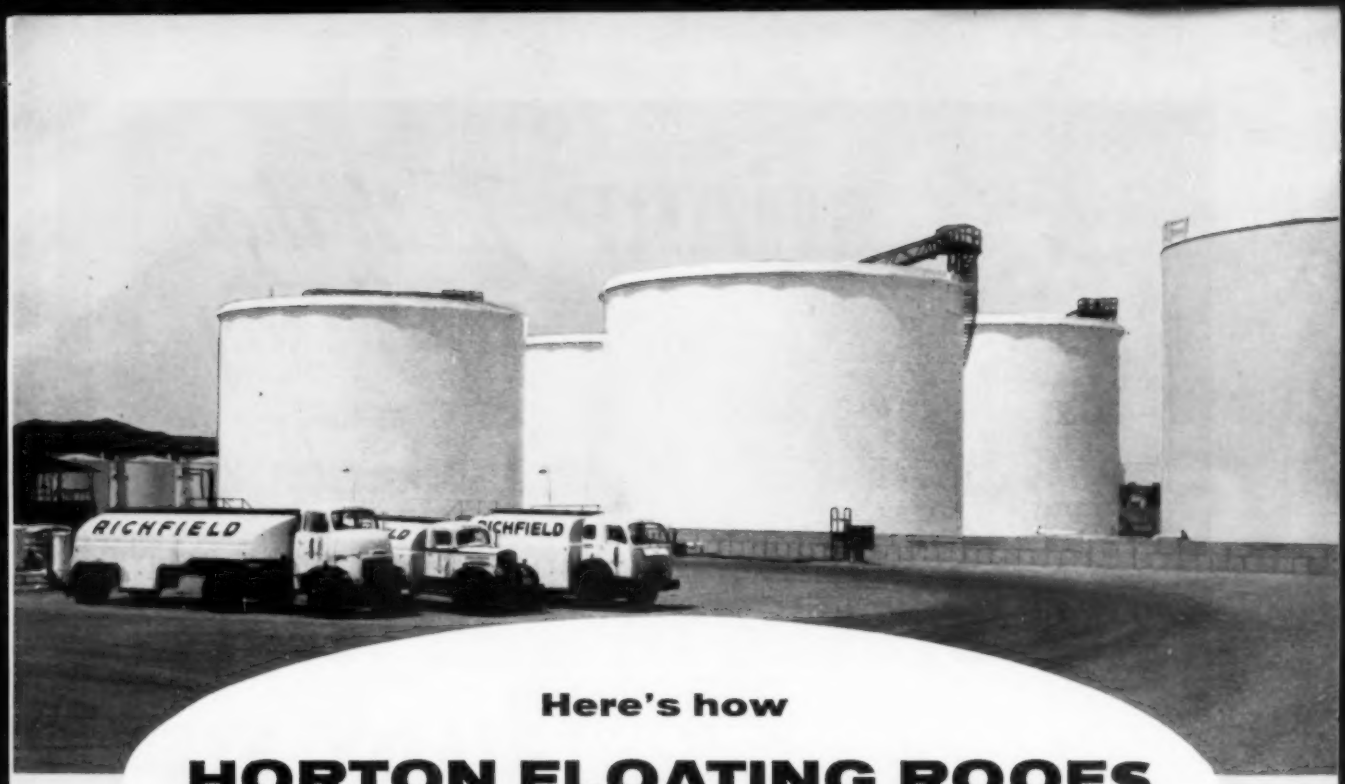


Here's how

HORTON FLOATING ROOFS

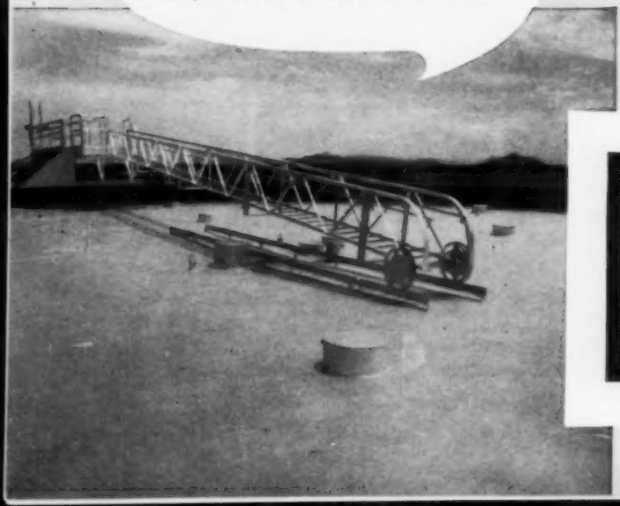
control evaporation loss

at Phoenix terminal

Four storage tanks equipped with Horton® Double-Deck Floating Roofs are reducing evaporation losses, corrosion and fire hazard at the Richfield Oil Corporation's Phoenix, Arizona, terminal on the Southern Pacific Pipe Line. The Horton Floating Roofs float directly on the surface of the liquid in the tanks, eliminating space for air-vapor mixture to form, be vented and lost.

Horton Floating Roofs are built in three types—Double-Deck, Pontoon and Pan. Write our nearest office for further information, estimates or quotations.

Below: View inside one of Richfield Oil Corporation's tanks equipped with a Horton Double-Deck Floating Roof. The Horton Seal around the edge of the roof efficiently closes the space between the deck and the tank shell.



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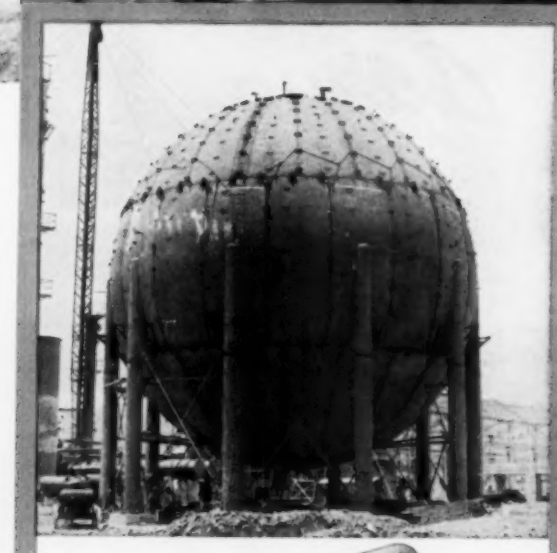
Spherical storage for ammonia, fabricated in Wyatt's Houston plant and erected in Taiwan (Formosa).



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*1 mil=.001 inch. A corrosion rate of 216 mils per year means that the corrosive attack, if uniform, would have corroded away the entire surface of the metal to a depth of .216 inches in a year. However, the real danger of high corrosion rates, as the coupon shows, is the much deeper and faster penetration occurring at localized areas.

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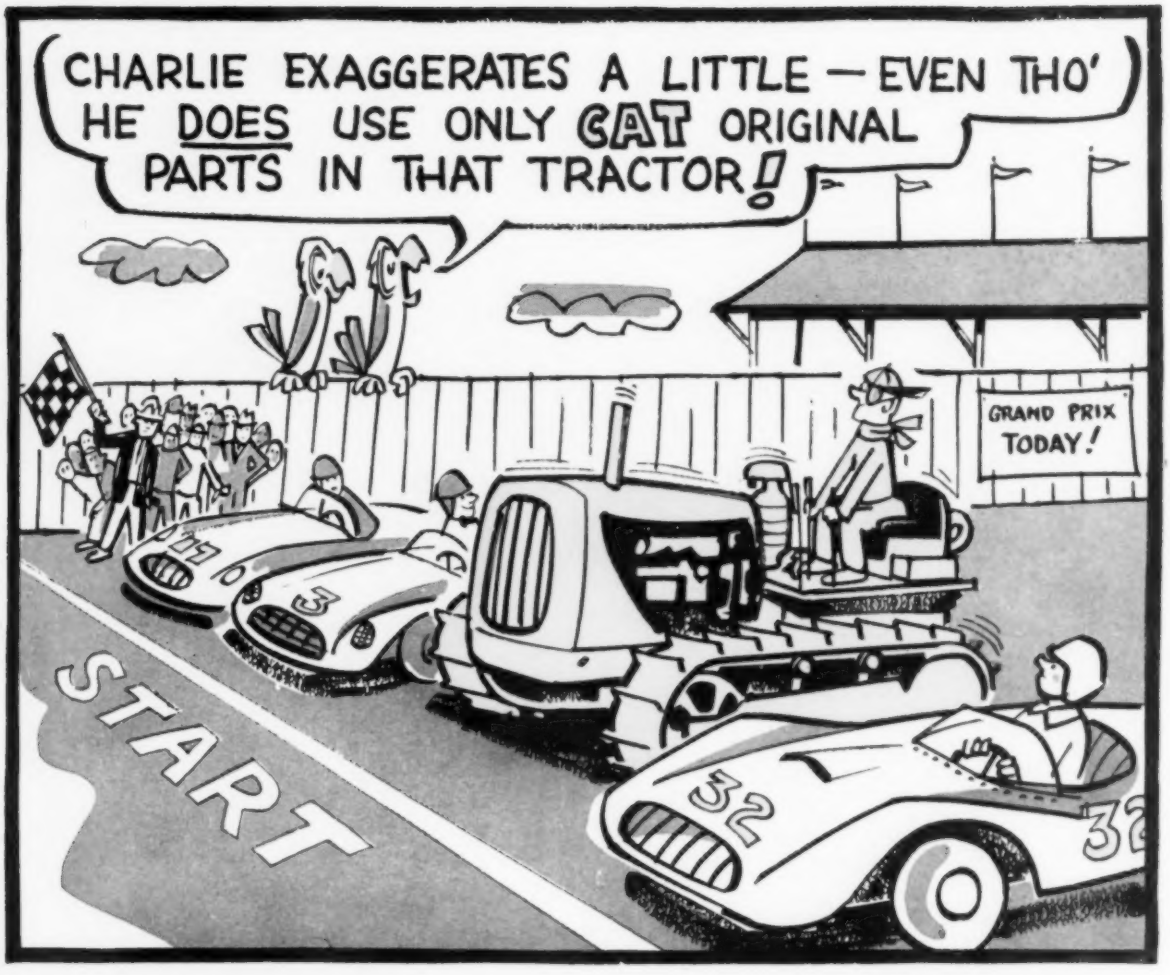

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Trans-Canada Pipe Line lays 34-in. pipe to take Alberta natural gas to eastern Canada. Here line sinks down the bank of Swift Current Creek, north of Swift Current, Saskatchewan.
— Photo Courtesy Trans-Canada.

Canada Has Its Biggest Year

Pipeline construction opened up new markets, stimulated drilling . . . Refineries added 112,000 bbl daily capacity . . . New petroleum investment reached $¾ billion

H. G. Cochrane

CANADA'S petroleum industry has done it again, with a new production record of 170.6 million bbl, a 32 percent gain over the previous year. Production of natural gas also showed an 11½ percent gain over previous year.

Domestic demand for crude rose 12 percent and exports recorded a threefold increase over 1955. Comparing these gains with the 10 percent increase in value of Canada's gross national product for 1956 over 1955, the industry's showing underlines its importance to the national economy.

Eastern Prairies Has Best Gains

Production of crude reached a monthly peak of 520,000 bbl daily compared with the best monthly average of 411,000 bbl daily in 1955. At the end of the year potential production was almost double the actual oilfield output. The meaning of this was that Canada could be fully self-sufficient in oil if transportation facilities were adequate to carry it to all economic market areas.

Alberta fields produced 85 percent of the total, with Saskatchewan supplying 11 percent and Manitoba 3 percent. Even British Columbia joined the ranks of the provinces which produce oil in commercial quantities.

Saskatchewan's percentage gain in production over 1955 led the others with a 66 percent gain over the previous year, while Manitoba's gain over the previous year was 37 percent. Comparing these gains with Alberta's 26 percent gain for the year indicates the extent to which the two eastern prairie provinces are catching up with Alberta, their oil-rich neighbor.

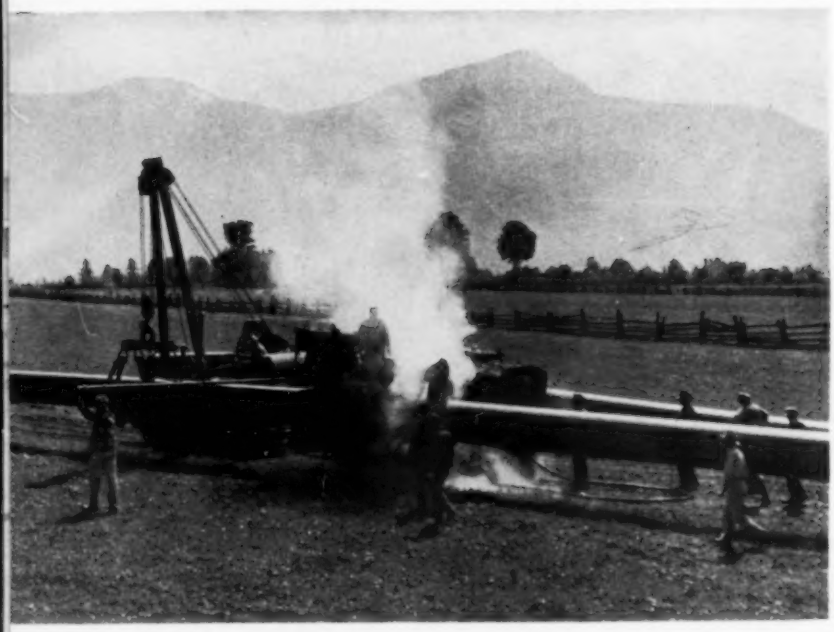
Drilling, Completions Kept Pace

Drilling continued active last year, with close to 3300 wells drilled to completion. At year's end 276 rotary drilling rigs were on the active list, while the average number in use throughout the year was about 250. Activity was spread throughout all provinces, with footage at 15½ million, up by 10 percent from 1955.

Alberta led in rate of development and exploration with 1864 completions and 162 rigs working at the close of the year, 78 of them on exploration. In the Pembina field alone some 800 holes were drilled, doubling the number of producing wells as of a year ago.

Saskatchewan accounted for about 30 percent of the drilling for the year, mostly in the southeast corner of the province. Here 72 rigs were active at the end of December. Wildcat drillers

Mr. Cochrane is with Power Corporation of Canada, 355 St. James Street, W. Montreal 1, Canada.



Coat and wrap machine in Fraser Valley near Chilliwack, B.C., only a few miles from Huntingdon where the line crosses the Canadian-U. S. border joining the Pacific Northwest Pipeline.

— Photo Courtesy Westcoast Transmission.

A line of drying laundry brings a domestic atmosphere to an oil rig at Mobil Oil of Canada's Duhamel field operations in northwestern Alberta.

— Photo Courtesy Socony Mobil.

were most active in the central west portion, with 21 rigs operating. In this area large permit blocks were taken out following light oil discoveries in the granite wash formation at Red Earth Creek.

Manitoba drilling, which was less active last year, is now being stepped up, with wildcat drilling accounting for about a third of current operations. There was no wildcat drilling in the Northwest Territories last year, though interest is growing in the area as a source of gas and oil.

British Columbia ranked third in drilling activity last year; 27 rigs were operating at year end, 18 of them on exploration. All but one of the 27 were in the northeast sector due to the incentive created from the need for natural gas to fill the Westcoast pipeline later this year.

Reserves Up

These discoveries increased proved reserves in the four western provinces to well over 3½ billion bbl, compared with about 3¼ billion a year ago. The number of producing wells now stands at just about 9000. At the same time proved and probable reserves of natural gas were increased from 21 trillion cu ft a year ago to about 23 trillion ft at the end of 1956. This resulted in part from continued search for oil pools and partly from an intensive and successful search for gas stimulated by commencement of construction on the two huge pipeline systems, one from northern British Columbia to serve Pacific Northwest states and the other from Alberta to serve Canada's central provinces.

Refining Capacity Added

Some $200 million was invested in 1956 for the industry's plant and equipment. Large though it was, this expansion was overshadowed by investment for acquiring mineral leases and exploration permits and in the search and development of oil and gas fields, which totalled more than half a billion dollars.

Capital expenditures on 17 refineries added 112,000 bbl of daily capacity, bringing total refinery potential for all Canada to 708,000 bbl daily at the end of December. This was 15 percent greater than the total a year previously and three times as great as it had been 10 years ago.

Attainment of self sufficiency in crude supply for virtually all refineries within economic range was a highlight of 1956 progress. Completion of a lub-manufacturing plant, permitting replacement of practically all the specialty demands formerly coming from the United States, and the opening of a Canadian tetraethyllead plant in October, also contributed to a more balanced production.

Pipeline Construction Sets Record

1956 also witnessed tremendous activity in pipelaying, both for oil and gas pipelines. Altogether some 3100 miles of gathering and distribution lines were laid; 740 were mains ranging in size from 6 to 34 in. in diameter.

Of these, the major accomplishments for the year included completion of some 450 miles or 70 percent of Westcoast Transmission's 30-in. pipe from the Peace River area of B.C. to connect with the Pacific Northwestern System at Huntington on the International Boundary. It also included 230 miles of Trans-Canada Pipelines' 34-in. western section from Alberta to Winnipeg. Additional looping also was carried out on the Interprovincial Oil Pipeline in Saskatchewan and Manitoba.

During 1957 Interprovincial, gearing its program to a refinery expansion now under way in the Toronto area, will extend its main line from Sarnia to Toronto, a distance of 185 miles. It will continue its looping program on the prairie section, to add another 40,000 bbl daily to capacity by next fall. These programs call for an expenditure of $25 million.

Big Gain in Exports

Crude exports now amount to a third of total demand. The volume had been increasing steadily over the past year, particularly during the fourth quarter. The Transmountain Pipeline commenced the year with a throughput of 100 million bbl daily, but by October it had risen by more than 50 percent.

Plans were then made to install two new temporary pumping stations. With these in service capacity was increased to 184,000 bbl daily, which will increase during the summer to 240,000 bbl when the permanent stations are completed, and to 300,000 by the end of the current year.

Exports of crude at year's end had attained a rate of some 44 million bbl yearly, compared with some 15 million bbl the previous year. This was due to the opening up of a new market in California and to the growth of markets in both the Lakehead-St. Paul areas and in Washington State. Also in the latter part of the year a 250,000-bbl tanker shipment went to Japan. Roughly balancing this export demand for a third of Canada's production is Canada's dependence on imports of foreign oil, which is also about one third of Canadian consumption.

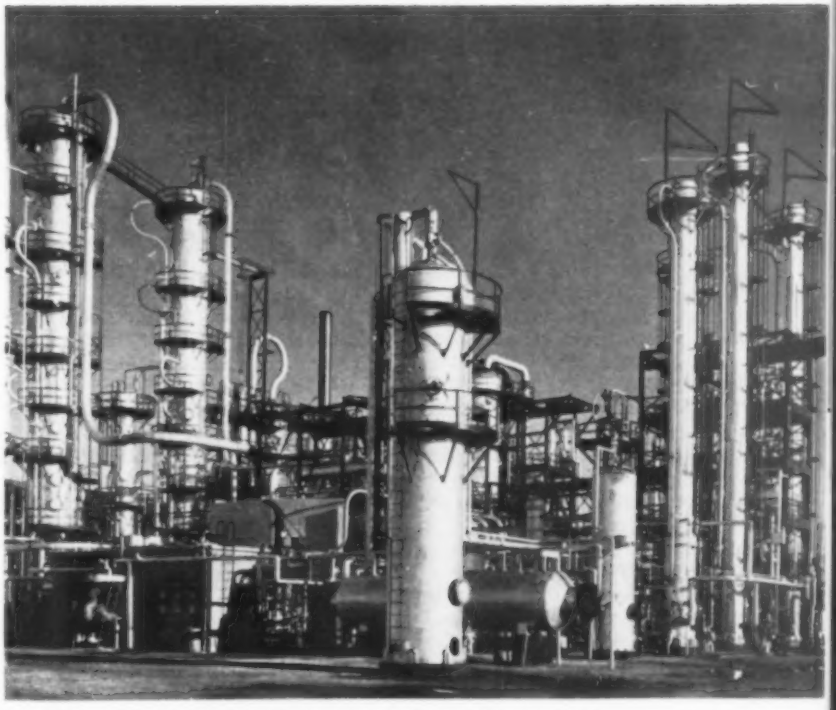
Middle East Unsettlement

The Suez Canal closure in late 1956, creating a shortage of a million barrels daily in Western Europe, had an indirect bearing on the prospects for Canadian oil exports. More crude shipments to the California market are already resulting, releasing extra tanker space and freeing more South American oil for Europe.

Independent producers in Alberta were showing renewed interest too in the possibilities for extending the Interprovincial pipeline beyond Toronto, to serve the rich Montreal area market which consumes some 225,000 bbl daily of imported crude. Most of the Montreal refineries that use Venezuela oil will have no trouble in getting their supplies, but the big new Canadian Petrofina refinery, which operates on Middle East oil, may have to look elsewhere.

Inevitably there is considerable opposition among the larger western producers towards taking over the Montreal market, for such a move would place Canadian oil in direct competition with foreign oil and undercut the wellhead price advantage it enjoys throughout the rest of Canada. Even without entering Montreal, Middle East nationalism may provide a gradual boost in prices from which Western Canada will benefit. Already increases of 35 cents a bbl had been posted early in 1957.

Canada may benefit, too, through increased investment by the big international oil companies in exploration and development in its politically secure million square miles of potential oil areas. On the other hand, it is realized that the Middle East is still the logical source of supply for Europe, and Europe still remains the logical market for Middle East oil. For this reason there is a strong body of opinion within the industry that too much in the way of permanent gains from the current emergency should not be expected.



Overall view of British American Oil Company's Refinery at Calgary, Alberta.
— Photo Courtesy British American.

Tar Sands Development

Just after the turn of the year Royalite Oil Company Ltd. and associates announced the investment of $50 million over the next four years in the development of the fabulous Athabaska tar sands 350 miles northeast of Edmonton. The company will start building a separation plant this spring to extract 20,000 bbl of oil daily from the black, tacky sands, using a centrifuge process not far different to the way a washing machine operates. Later a processing plant will be built, together with a townsite and a 350 pipeline to Edmonton.

Over the past 30 years scientists and engineers have been carrying out research and testing methods of separating oil economically from the vast deposits, covering 30,000 sq miles and estimated variously to contain 100 to 250 billion bbl of reserves, 20 to 50 times the amount of free flowing oil discovered in western Canada to date. The Federal Government, the Alberta government and several international oil companies have all spent millions on the project. Had a vast supply of free flowing oil not been discovered on the prairies the tar sands would in all probability be in production today.

Under the proposed process the oil will be pumped after separation to a sulfur plant which will produce an estimated 140 tons of sulfur daily. The resulting crude should test 20-30 gravity, and will sell at a premium price over crude from wells because it will yield more high-value products, from premium gasoline to jet and diesel fuel.

Royalite's retail network will absorb the entire initial production. Timing of the announcement following the recent events in the Middle East bolsters confidence in Canada's future as a leading oil producing nation of the future.

Oil for Alaska-Yukon Area

Plans are announced for a refinery and oil pipeline to service a marketing system to be established in Alaska and the Yukon, covering all major interior areas not accessible through seaports. The 6500-bbl a day refinery to be located at Haines, Alaska, will be the first in the area. Alaska-Yukon Refiners and Distributors, Ltd., of Edmonton, have already commenced construction on a three-year program costing several million dollars.

Marine terminals, tankage and loading facilities will be at Haines. Bulk storage is planned at Whitehorse, Haines, Fairbanks, Anchorage, and Juneau. Facilities will be owned by subsidiaries, and leased and operated by Royalite. Some of the equipment for the refinery and a 2500-bbl per day cracking unit has been acquired. The

refinery is scheduled for operation in 1958.

Bright Future for Gas

Production of natural gas in 1956 amounted to close to 173.3 billion cu ft, up 11½ percent from the previous year and three and a half times as much as was produced 12 years ago. Canadian consumption at 151 billion cu ft last year, has shown a corresponding growth. Of the total, 87 percent came from Alberta, 7½ percent from Ontario fields, 5 percent from Saskatchewan, 1 percent from New Brunswick and a trace from the Northwest Territories.

A year ago the Canadian Gas Association recorded 450 Canadian communities served with natural or manufactured gas by 47 distributing companies or utilities, 82 percent of them with natural gas.

Gas Development Held Up

Commencing with the discoveries of important gas and oil reserves in the late 'forties,' controversies and indecision on the part of the Federal and Alberta governments and the Federal Power Commission on policies resulted in a stalemate lasting more than seven years. During this time gas reserves were building up rapidly to well over 20 trillion cu ft. Throughout this period many pipeline companies sought incorporation and competed for the right to serve the huge untapped markets in Central Canada and the Pacific States.

At last, in October 1955, FPC approval for import of British Columbia gas to the Pacific States was given, and Westcoast Transmission commenced construction of its 650-mile pipeline to bring Peace River gas to interior communities of British Columbia, to Vancouver, and to connect up with the Pacific Northwest Pipeline Corporation's system south of the Canada-U. S. boundary.

In June 1956, after weeks of bitter debates in the Canadian Parliament, legislation was passed authorizing Trans-Canada Pipelines to build the western section of its 2300-mile line from Alberta to Montreal, with completion as far as Winnipeg scheduled for this summer. The first 230 miles of pipe was laid in 1956. Ability to finance the project has been acknowledged by Ottawa and a crown company will build the 675-mile section across northern Ontario from the Manitoba boundary to Kapuskasing. Trans-Canada will build as far as Fort William this summer, as well as the stretch between Toronto and Montreal. Completion of the entire line to Montreal is scheduled for the end of 1958.

Financing of the Trans-Canada project is predicated on sales contracts with Canadian distributing companies only, and expected deficits for the first three years of full operation. Eventually, if and when FPC approval is forthcoming for importation of Canadian gas to central states via Emerson and Tennessee Gas Transmission's proposed connecting pipeline, profits should build up rapidly. Expected deliveries to Canadian distributing companies are estimated at some 100 billion cu ft the first full year of operation, rising to double that figure the fifth year.

The Westcoast Transmission project, commenced late in 1955 and now 70 percent completed, includes 650 miles of 30-in. main from Taylor, B. C. to the U. S. Boundary line, a $15 million gas processing plant at Taylor, gathering lines and other facilities. Planned initial flow is now for 400 million cu ft per day and full capacity is 660 cu ft per day. Cost of the project is now $225 million. Largest customer will be Pacific Northwest Pipeline Corporation which serves the Pacific States, but both British Columbia Electric and Inland Natural Gas are also customers, the former serving the Vancouver area and Vancouver Island, the latter supplying communities in the British Columbia Interior. Deliveries will begin in September 1957.

Signing of another Westcoast contract with Pacific Northwest was announced early this year, for export via Kingsgate, B. C. of 125 million cu ft per day from the recently discovered Savanna Creek field in southwestern Alberta. The proposed 174-mile 30-in. pipeline from the field to the border would also serve communities in the Crow's Nest Pass and other southeastern B. C. towns. The project, estimated to cost $45 million, also includes a 500-ton per day sulfur plant in Alberta.

Pending Alberta and FPC approvals for this new contract, however, certain distributing companies in midwestern states are eying the Savanna Creek field as an alternate source to Trans-Canada deliveries via Emerson. Their plan would be to pipe the gas across Montana and North Dakota to serve large areas in north central states including St. Paul-Minneapolis. Their application to FPC might further delay the FPC hearings on the Tennessee Gas Transmission Application to import Trans-Canada gas via Emerson.

Completion of these two huge pipeline systems over the next two years will release additional huge volumes of natural gas to thousands of Canadian customers and to the rich untapped markets in Washington, Oregon, California, and Idaho. Sales contracts in Canada alone signed by the two pipelines, added to the normal expected growth of consumption in Alberta and Saskatchewan in areas not dependent on the big pipelines for supply, may well double 1956 Canadian consumption by 1960 and increase it three or four-fold by 1965.

Consumption by Areas

Sales contracts already signed between Westcoast and its distributing customers in Canada call for delivery of 18 billion cu ft to Inland Natural Gas the first full year, rising ultimately to some 29 billion ft. Delivery to British Columbia Electric calls for 19 billion ft the first full year, ultimately rising to some 32 billion ft. Exports to the U. S. A. will be 146 billion initially and 241 million ultimately. The city of Vancouver is already getting a temporary supply of American gas from the San Juan Basin in New Mexico via the Pacific Northwest Pipeline. With completion this year of the Westcoast project the flow will be reversed and Canadian gas will begin to flow southward to Pacific states.

Trans-Canada expects to deliver a total of 103 billion cu ft the first full year of operation, increasing to some 200 billion ft the fifth year.

Offshore Drilling

The last two years have seen renewed interest in offshore drilling for gas in the waters of Lake Huron, Lake Erie, and Lake St. Clair, started in a small way some 15 years ago. Several companies have exploration permits covering about 10 sq miles, most of it in Lake Erie. Some of the 50 or more wells drilled to date are as much as ¾-mile from shore.

Most of them have been drilled and capped. Some have shown an open flow production rate up to 900,000 cu ft per day. Wellheads are left 30 to 40 ft below the lake surface. Reserves in these offshore areas have not been announced by Consolidated West Petroleum, the largest explorer in the field, but the company has indicated reserves are sufficient to support an annual production of 1.8 billion cu ft at present.

1957 Prospects Good

Based on last year's accomplishments, signs point to another excellent year for Canada's petroleum industry in 1957. Though some observers feel the tight money situation may act as a depressing influence, the larger producers depend more on working capital than on borrowing. With direct employment of upwards of 21,000 and many more employed indirectly, annual expenditures are close to three-quarters of a billion dollars. Large reserves of gas and oil are proved up and markets are growing. The industry is firmly established as one of the most important bulwarks of the national economy. ★ ★ ★

Welfare benefits cost $1278 a year for each hourly-paid employee in the petroleum industry, the highest fringe payments in U. S. industry . . . Why not get credit for this high rate?

THE $1278 CHALLENGE

J. C. Hurley

ASSUME that tomorrow we received a demand from the unions to grant each hourly-paid employee $1278 per year in welfare benefits. Our immediate answer would probably be an unequivocal, unqualified "no." That would be a logical answer, for such an outlay would unduly increase our costs for each hour of productive labor.

U. S. C of C Survey

Yet that's what's occurred during the past 20 years through the process of liberalizing one benefit plan at a time, increasing payments for social security and other taxes, and a host of other benefits (insurance, paid rest periods, jury duty pay, paid holidays, tuition refunds, savings plans, etc.). The cost of fringe benefits in 1955 in the petroleum industry averaged $1278 for each hourly-paid employee according to the Chamber of Commerce of the United States.

In preparing this survey, the Chamber had the cooperation of 1000 employers, 19 of them in the petroleum industry. The $1278 figure is applicable to them and not necessarily to all refiners and marketers in the petroleum industry. However, it does furnish a rough indicator for the industry.

Comparisons

Here's how the petroleum industry compared with the other 19 industries surveyed in 1955:

U. S. Chamber Survey
1955 Fringe Benefit Payments

	All industry	Petroleum (19 companies)	Difference
Percent of Payroll	20.3%	24.3%	+ 4%
Cents per hour	39.2c	61.0c	+ 21.8c
Dollars per year (per employee)	$819.00	$1278.00	+ $459.00

When fringe benefits are expressed as cents per payroll hour and annual dollars per employee — the petroleum industry headed the list.

EDITOR'S NOTE: This is condensed from a paper presented before Western Petroleum Refiners Association, regional meeting, El Dorado, Arkansas, October 18, 1956.

Costs Vary by Size

The survey showed larger firms tend to pay higher fringe benefits.

Fringe Benefit Payments by Size of Company — Petroleum Industry
(19 companies)

	Per cent of payroll
All companies	24.3%
Under 500 employees	20.2%
5000 or more employees	28.6%

According to the eleventh edition of "Petroleum—Facts and Figures," published by American Petroleum Institute, the average number of employees per company in the petroleum refining industry in 1954 was 782. If the typical company's fringe benefit costs averaged $1278 per employee in 1955, its yearly cost would be $999,396.

The survey showed that the petroleum industry had the highest hourly earnings of $2.510 or $5259 per year per full-time hourly employee. If the fringe benefit costs were added to those wage figures the picture would be $5259 plus $1278 or $6537 annual cost per employee.

This high rating in wages and fringe benefits is probably one of the reasons why our turnover is so low and why jobs in the refineries are coveted.

Items Included

The U. S. Chamber fringe payments included the following items:

Fringe Benefit Payments Per Employee in the Petroleum Industry
(Company cost only)

	Per Cent of Payroll	Cents Per Hour	Dollars per Year per Employee
Legally required payments (Social Security, workmen's compensation, etc.)	2.8%	7.0c	$147
Pensions and other agreed-upon payments (life hospital ins., severance pay, discounts, etc.)	9.9	24.9	521
Paid rest periods, lunch periods, wash-up time, travel time, etc.	0.4	1.0	21
Payments for time not worked (vacations, holidays, sick benefits)	8.3	20.8	436
Other items (jury duty, etc., savings plan, union steward pay, etc.)	2.9	7.3	153
TOTAL	24.3%	61.0c	$1278

Difficult to Compare

The Chamber recognizes that there are wide differences of opinion regarding just what constitutes fringe benefits and how they should be computed. Some employers do not consider workmen's compensation, suggestion awards, and other items as fringe benefits. Others regard shift differentials, overtime, and other payroll items as fringe benefits.

This difference of opinion indicates the need for a uniform method of computing and defining fringe benefits. Only with this safeguard will we be in a position to compare our company's fringe benefit costs with other companies, for use of management, discussion in union bargaining, or education of employees.

Members of the petroleum industry can see that with their high fringe benefit costs, there is a real incentive to receive full value and recognition for this expenditure of about $1278 per hourly employee per year.

Servicing

We can run a *poorly serviced* high-powered car for hundreds of miles at high speeds and probably it will not fall apart suddenly like the one-horse shay. But keep up that pace, day after day, and the glistening chromium and the smooth acting engine will be ready for the junk heap. Benefit plans are similar. They, too, must be properly serviced.

Regardless of how many specialists are called in to devise and install a plan, an employee's appreciation of the plan will be in direct ratio to the way his claim or problem is handled. A refinery, for instance, may process 600 group hospital claims per month involving total payments of about $50,000 and receive little if any favorable comment. If one hospital claim is improperly paid or one retirement check delayed for a month, however, there will be criticism, maybe a union grievance, a letter to top management, or even a law suit.

With poor administration, the job

of the supervisor, the personnel men, and the operating people is to settle grievances dealing with benefit plans. Smooth and unruffled production does not result when employees and union representatives are discussing benefit plan grievances with top management, an arbitrator, or a Congressional committee.

To see how some fundamental principles can help maximize the values of a benefit plan program, let's examine some of them.

The Author

Joseph C. Hurley holds a BS degree from University of Illinois and a Doctor of Jurisprudence from De Paul University College of Law. He has been employed by the Standard Oil Company (Indiana) since 1945 in the general office in Chicago and been in the employee relations department since 1947. His present assignment is assistant supervisor of plans and benefits.

He was inducted into the Army in 1941 as a private and left the service in 1945 with the rank of captain.

His civic activities include membership on the State Reemployment Rights Committee for veterans in the state of Illinois, member of the Kiwanis and Toastmasters clubs.

1. LET THE SUPERVISOR INTERPRET IT

A face-to-face conversation between two people represents ideal communication. All other communication efforts try to retain as much as possible of its directness, simplicity, and two-way give and take. Long experience indicates that the supervisor plays the most important role in benefit plan administration. Supervisors must do a large share of the job of interpreting and explaining the plans to their people.

The immediate supervisor is one of the key men in supplying employees with information about the benefit plan program for these reasons:

1. He is the person to whom an employee logically turns with questions and problems connected with his day-to-day work and usually his family problems.

2. He is convenient and usually accessible to the employee. An employee may feel that an answer to a question is not worth the trouble of a trip to the personnel office.

3. The supervisor who explains the retirement or savings plan to his men, and thus helps them, is likely to be accorded increased respect by them.

4. Such a conversation offers an excellent opportunity to improve industrial relations at the work bench, which is a key spot in any industrial relations program.

It is difficult to say how many benefit plan questions a supervisor should be able to answer simply and satisfactorily. Perhaps 50 per cent is an attainable goal — 100 per cent is not. Even persons — such as myself — who are devoting full time to benefit plans haven't that amount of knowledge. Many of the questions and problems have *not* been decided and involve a policy decision.

For example, our policy provides that a vacation will be reduced because of certain absences of 30 consecutive days during the preceding calendar year. An employee was not advised by his foreman that his vacation was to be reduced 7 days. He remained away for two full weeks. What should be done about the overpayment? Shall he refund the overpayment or keep it? He was allowed to keep it — for the supervisor made the error.

The supervisor should know to whom such unusual questions and criticisms of the plan should be referred. He should *not* hesitate to communicate adverse comments about the plan operation or suggestions for improving the plans.

Many techniques can be used to give supervisors sufficient knowledge about the plans so that they can answer the majority of questions. The basic step should be to hold group meetings for supervisors on company time when each new plan is announced. Use effective visual aids and trained conference leaders. Allow ample time for questions.

Periodic re-education for supervisors can be in the form of annual statements, mailings, articles, posters, and gimmicks.

Continuing guidance "after the fact" can be afforded to local management to reduce the incidence of errors of judgment. Decentralization of benefit plan administration also hastens the development of skills in the executive ranks of the organization at the operating level.

2. PLANS SHOULD APPLY UNIFORMLY

Hundreds of problems are presented each year on the benefit plans. These are knotty problems which usually require a policy decision, a change in policy, or just a flat rejection. The most difficult problems to resolve are those in which the location manager is recommending an exception to a policy. Many times, no reason is given other than the fact that a good, loyal, and conscientious employee is involved.

For example, under our sick benefit plan an employee with 10 or more years of service is entitled to 12 weeks at full pay and 40 weeks at half pay. Recently, a man was short *three* days of requalifying for 12 weeks at full pay and would be on half pay sick benefits. It appears that over the years he had made frequent use of the plan. This meant that he took a day off for every cut finger, or back ache. His supervisor asked us to overlook the fact that this man had not requalified because he was a good, loyal, conscientious employee.

You will also get the opposite recommendation. Do not give Joe Standard Oiler the benefits to which he is entitled because he is an ornery, no good so and so.

Benefit plans are like the Constitution of the United States which applies equally to everyone and without favoritism. Every person, whether he is a good or a bad citizen, receives comparable treatment under the Constitution. A benefit plan is likewise a set of rules to be used for the welfare of all employees and their dependents without favoritism.

It is, also, not advisable to set up non-contributory plans and polices on the basis that the benefits will only be granted to "good" employees. For example, a leave of absence rule may provide that local management can grant an additional leave of absence if the employee's service, loyalty, and other conditions warrant the granting of the additional time. Local management will have no objective standards to follow in making such a decision and there will be charges of favoritism.

Liberal benefit plans, adequate wage levels, extensive training programs, and other factors usually associated with a good employee relations program will not, standing alone, produce desirable attitudes of employees toward their jobs and the company. Satisfactory employee attitudes will be achieved only if in addition to these factors there is considerate, friendly, equitable, and businesslike treatment of all employees and their problems by all levels of supervision. Another way of stating this vital principle of giving everyone equal treatment is to apply the Golden Rule.

We also think it is best to have the same plans for all employees in the company whether they are hourly-paid or salaried, nonsupervisory or supervisory. The only distinction should be on the basis of earnings.

In this connection, consideration must also be given to the requirements

Youngstown's "big 5"

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Here are the "Big 5" reasons why Youngstown Electric Weld Line Pipe is your best buy:

1. It bends readily
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3. Line up characteristics are excellent
4. Weldability is outstanding
5. Long lengths save you time and trouble

It's no secret that installation crews prefer Youngstown Electric Weld Line Pipe for its easy line-up qualities. Good line-up is a direct result of the extra care that goes into its manufacture. To achieve the optimum in roundness, each length of Youngstown Pipe is placed in an hydrostatic expander, here, internal water pressure forces the pipe out against the solid steel walls of the mantle. The diameter of the pipe is thereby increased to a uniformly accurate size. Every length conforms to specifications—ends are truly round, uniform in wall thickness, squarely cut and properly beveled for welding. These excellent line-up characteristics are more evidence that it pays to specify Youngstown Electric Weld line pipe.

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of the Internal Revenue Service. In order for a trust fund to be tax exempt, the Internal Revenue Code requires that the trusteed savings or retirement plan must not discriminate in favor of high salaried employees and that a prescribed percentage of all employees participate in the plan.

3. DO NOT TAKE ADVANTAGE

This case shows how this principle works. A woman submitted her resignation on January 8, because of pregnancy. The supervisor to whom she submitted the resignation overlooked the fact that she was eligible for four week's sick benefits for the disability attributed to pregnancy. In addition, she was entitled to two weeks' vacation that year. The resignation was accepted.

If the employee and supervisor had been aware of those benefits, the employee would not have submitted a resignation and the supervisor would not have accepted it.

It is better to write the plans tightly and interpret them liberally in order to eliminate allegations that the little man always suffers the penalty.

Not only should an employer not take advantage of a technicality in benefit plan administration, he should usually go one step further and tell the employee of his rights under the plans.

4. TELL EMPLOYEE HIS RIGHTS

This is necessary since the most important and universal medium for communicating a benefit plan to your employee is the plan booklet. It may be —and far too often is—nothing more than a complete or very slightly condensed version of the formal, legalistic text.

Fortunately these formal booklets are getting to be the exception, but even if you breathe life, warmth, color, and children's language into the booklets, it's no assurance that an hourly-paid pipefitter or a stenographer will understand the plan. Perhaps they can't even locate the booklet when the occasion arises.

In 1955 we had that experience. Two-hour conferences were being held with our supervisors and union representatives to explain the proposed revisions to the benefit plans — including the adoption of a new savings plan. One day after one of these meetings, we were surprised to have a secretary who had been working on the plans say she didn't understand the savings plan even after typing, proofing, and reading all of the announcement material. As a result of that conversation, with union permission, two-hour conferences were held to explain the plan changes to every non-supervisory employee in the general office and at some locations.

As a result of such efforts we have about 95 per cent of the eligible employees enrolled in our savings plan and over 80 per cent are buying company stock with all or part of their contributions. Eight out of 10 are contributing six per cent of their gross earnings each pay period to the savings plan.

Today, these employees may have a fairly good understanding of the fundamentals of our savings plan. However, that is no assurance they will understand the plan as well 5 or 10 years from now when they wish to make a withdrawal or take other action under the plan.

Oftentimes, a problem under a benefit plan can be resolved in favor of the employee or the company. Who should get the break?

5. DOUBT SHOULD FAVOR EMPLOYEE

If there is reasonable doubt as to the interpretation of a plan provision, resolve it in favor of the employee.

For example, under the law a veteran is guaranteed reemployment if he makes application to his former employer within 90 days after being released from military service. One veteran made application for restoration 91 days after the date of his military discharge. Why? He was repairing his parents' home and had miscalculated the number of days. He was reinstated to employment because of these extenuating circumstances.

6. USE CONSULTATIVE APPROACH

Sooner or later there will come a time when you will have to change the benefit plan. In recent years our benefit plan package has been revised about every five years. When that happens attention has to be given to:

1. Plans being offered by other companies, particularly those in the oil industry.

2. Level of charges being made by local hospitals and doctors, cost of living, etc.

3. Earnings of the employees at a location and how much they can afford to contribute or want to contribute.

4. How current benefits compare with losses being sustained.

5. Whether benefits should be added on a piecemeal basis or should the entire benefit plan package be reconsidered in the light of changing conditions.

At this point, an element of research enters the picture and this calls for imaginative thinking on the part of the employer, the unions, and the insurance carriers.

The best approach in construction of a plan is the consultative approach. Ask the managers at your locations and the personnel men to tell you what changes are desirable. Your local personnel managers and supervisors can give you excellent suggestions about benefit plan changes, if you will listen to them. They are aware of what other companies in their operating area are doing to get their money's worth out of the benefit plan package. They know the psychological make-up of their own employees and about how far and how often you have to make changes in the benefit plans.

Regardless of what your benefit plan package may contain, a survey of your people will pay off when you are considering revising or adding to the program. Cost of the survey to you will be very slight. You'll get these hidden advantages which are probably more valuable than the changes suggested by the survey results:

. . . Your people will know their opinions were considered in actions relating to their welfare.

. . . They like to see concrete instances where what they suggest is deemed good enough to be adopted.

. . . They like the chance to blow off steam by telling off the boss.

. . . They like to be thanked by the company.

. . . The unions enjoy the chance to help sponsor a project.

7. KEEP THE PLANS SOLD

Usually when an employer installs a benefit plan he makes quite a splash when introducing it. He probably spent a lot of time selecting the right plan, proper amounts of coverage, and the best carrier. He also tried, in a careful modest sort of way, to impress his employees with what was being offered. Then, he has a tendency, because of the press of other work, to wash his hands of the whole matter.

Just how can we go about promoting and selling the plans. Many techniques can be used. You could publish a letter from a grateful widow as to what her late husband's group life insurance means to her and the children. You could publish an article on how long it takes an employee to accumulate a share of stock under the savings plan. You could publish figures on the enrollment in each plan and the number of claims paid, the number of retirements granted, etc.

These are formal, impersonal approaches. There are ways of personalizing the benefits. You can, through good personnel handling, get your employees to become your own best salesmen for the plans. A visit to a hospitalized employee whose bills will be largely or wholly taken care of by your group

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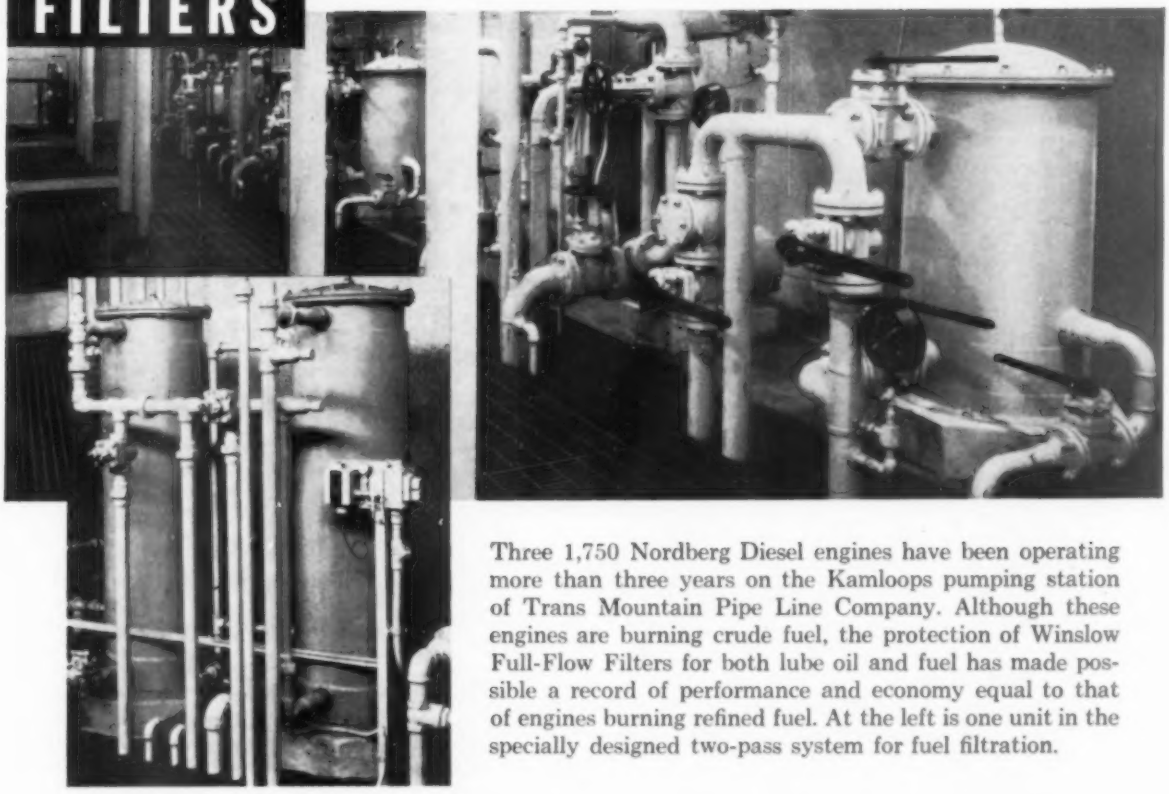
Case History Report No. 34 Shows Why Engines Protected by WINSLOW FILTERS Last Longer



Three 1,750 Nordberg Diesel engines have been operating more than three years on the Kamloops pumping station of Trans Mountain Pipe Line Company. Although these engines are burning crude fuel, the protection of Winslow Full-Flow Filters for both lube oil and fuel has made possible a record of performance and economy equal to that of engines burning refined fuel. At the left is one unit in the specially designed two-pass system for fuel filtration.

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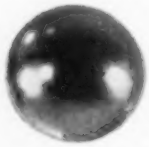

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...Partners in Progress

hospital plan is a logical place to start.

The planting of some idea in his mind along the following lines may be effective. "It's certainly too bad you have to be in here, but isn't it fortunate that you're covered by our group hospital plan so that you won't have to worry about paying most of the bills? When you get back to the job you'll have a good opportunity to let the fellows know how the thing really works."

When a union buys a group plan or forces an employer to buy one, it usually brags openly to its members. An employer cannot pat himself on the back quite so vigorously, nor can he appear to be too paternalistic.

Even though we are convinced that the employee understands every provision of any plan in which he is not enrolled, we must never give up trying to enroll him. Interview him at least once a year. Try a different approach each time and he will eventually make the proper decision. It requires not only a complete knowledge of the benefit plans, but understanding.

There is tremendous responsibility on us, particularly if one of these events occurs:

1. The death of an employee leaves his family practically destitute because he failed to enroll in the group life insurance plan. What would his family think about us? Whom would the neighbors blame but the company?

2. A family is burdened with an enormous hospital bill because of the failure of the employee to enroll in the group hospital and major medical plans. This has happened before. We shouldn't let it happen again.

3. *An employee retires at age 65 and has only the income from social security to live on because he failed to enroll in the retirement and savings plans.*

The effect of disabled, older workers existing on relief payments or other charitable sources alienates the good will of many people in communities. It is in handling these cases that industry can be vulnerable to public criticism.

Over the working life of an employee with a single employer, there takes place a subtle transfer of moral responsibilities from himself to his employer for his well being and security. We are not saying this is right and sound but it has been accepted as a condition by many influential minds of our time, in business and government.

Try as we might to return to other times when self-help was the accepted practice, the trend has been towards depending on others, either the employer or the government. Our government's policies and practices have intensified this trend.

You can't depend on your benefit plans to sell themselves, even though they stand ready to be one of your biggest assets in developing and maintaining employee morale. You've given your employees the bookcase — why don't you sell them a book every month to fill it? This requires not super salesmanship, but a basic sincere interest in the welfare of each employee and his dependents.

Conclusion

We have seen that many of the minor irritations that disturb employees arise not from lack of good intent on the part of management personnel, but because in the rush of the day's work those who resolve these problems lose sight of the many opportunities to do a better job in benefit plan administration.

The excellent safety records in the petroleum industry stem primarily from a top management conviction that it is their job to see to it that people do not get hurt. Firm establishment of that concept has done more to bring about safety-mindedness than the entire mass of safety slogans, guides and implementation measures. Perhaps extension of this same philosophy to the area of benefit plan administration would secure just as dramatic results in the petroleum industry. ★ ★ ★

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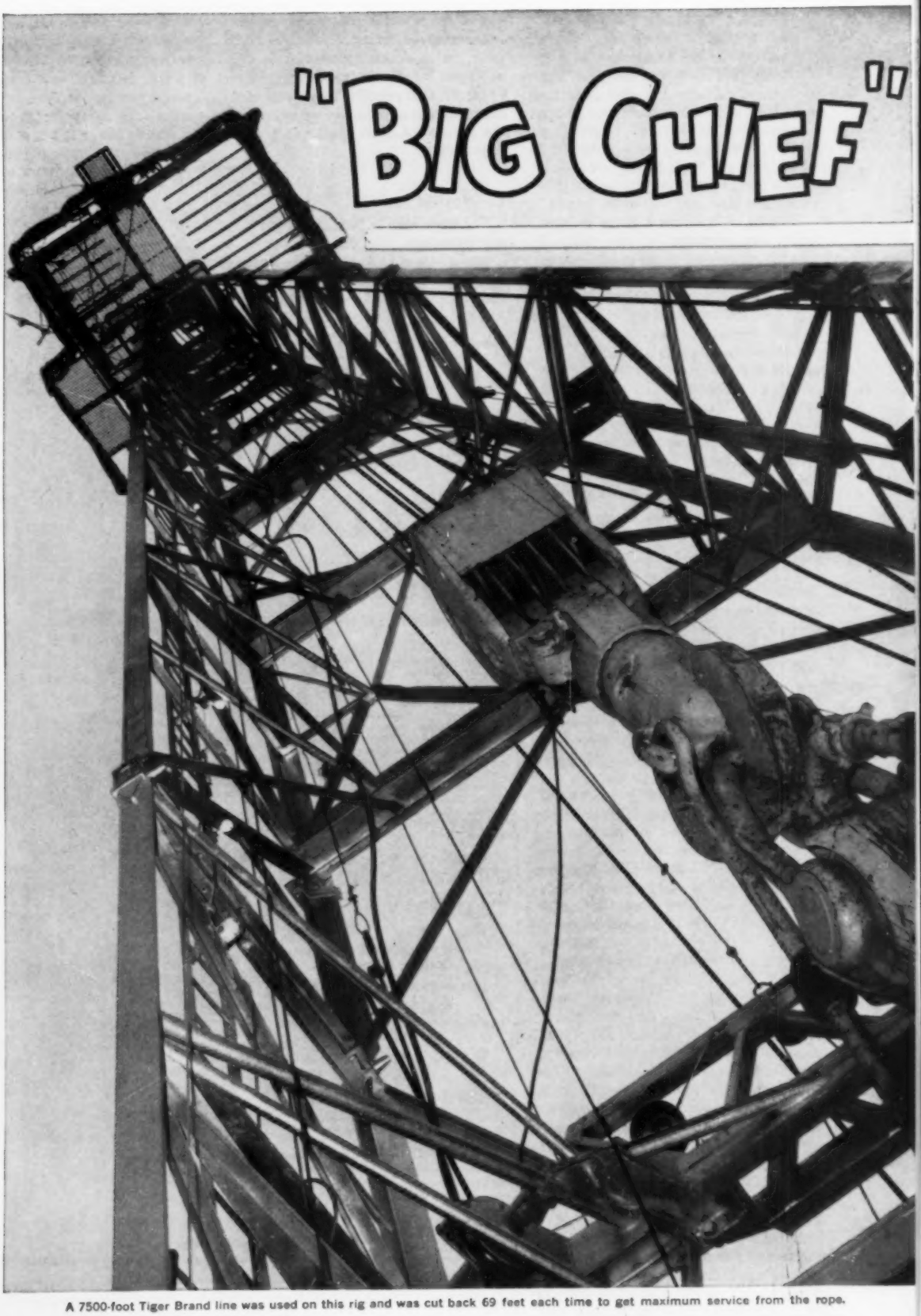

A 7500-foot Tiger Brand line was used on this rig and was cut back 69 feet each time to get maximum service from the rope.

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Drilling was tough in this area and vibration severe, but the Tiger Brand lines withstood it without trouble.

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The wire rope used on this rig was American Tiger Brand, 1¼-inch, 6x19 Monitor Excellay with wire core . . . the best drilling line you can buy. Write for complete information.

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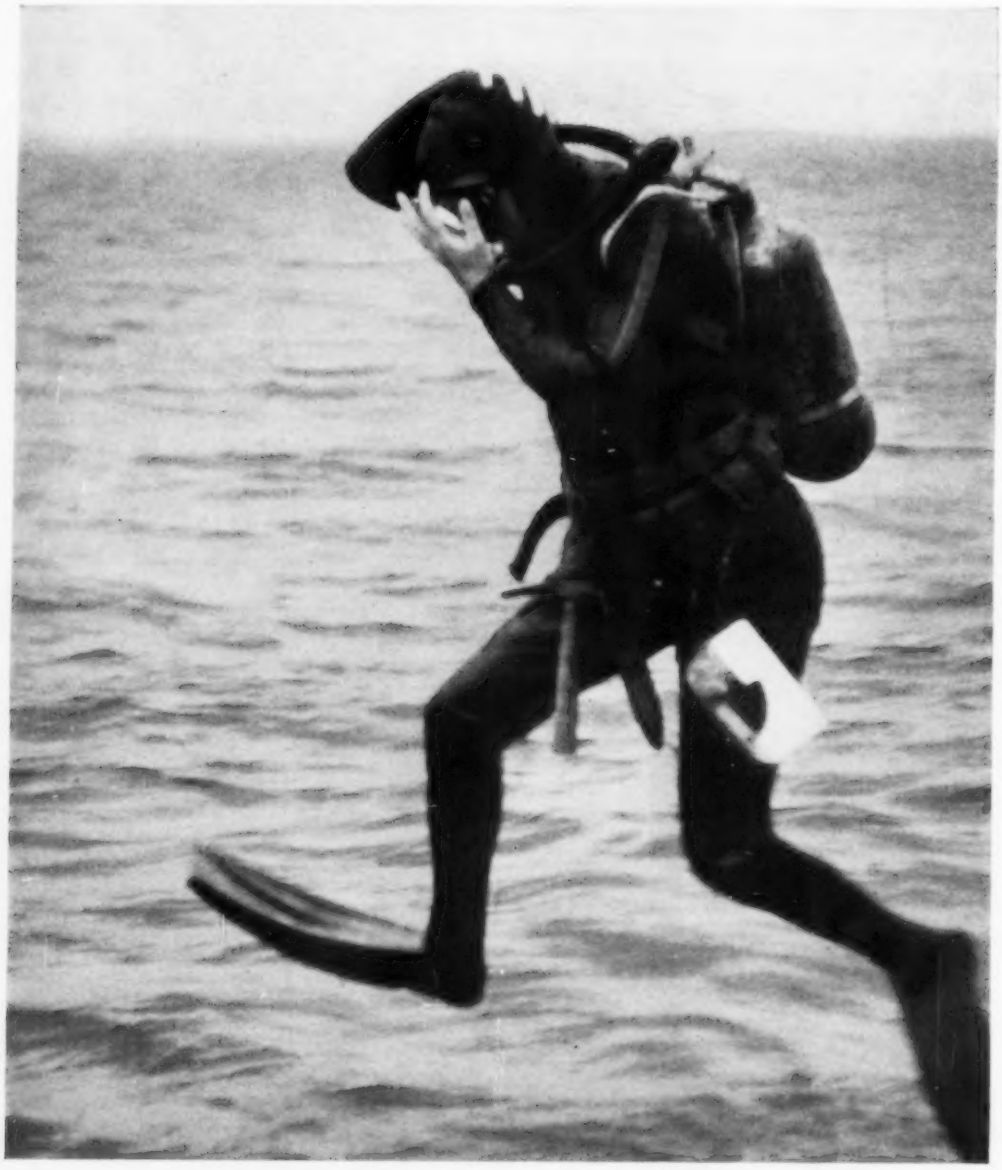

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LEASE SYSTEMS

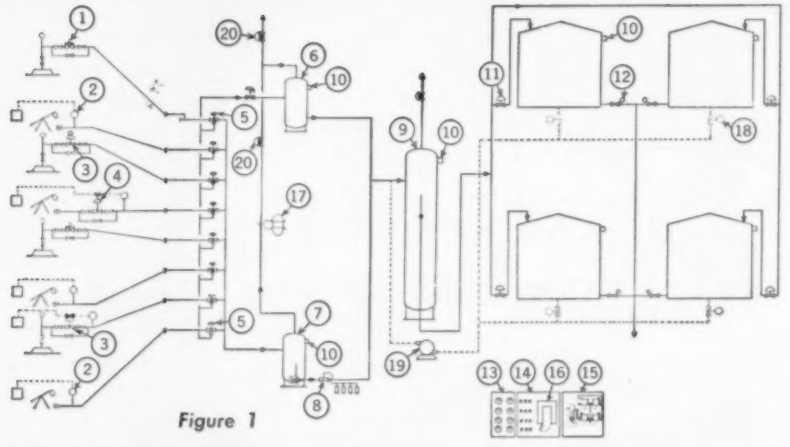


Figure 1

Legend:

1. Excess Flow Valve (Flowing Well)
2. Electrical Pressure Switch (Hi or Hi-Lo Shut-In on Pumping Well)
3. Pneumatic or Electro-Pneumatic Shut-In Valve (Hi or Hi-Lo Shut-In on Flowing Well)
4. Electro-Pneumatic Shut-In Valve (Hi or Hi-Lo Shut-In on Pumping Well)
5. 3-Way, 3 Position Header Valves
6. Production Separator
7. Metering Separator
8. Sampler W/Containers
9. Emulsion Treater
10. Hi-Level Detectors
11. Tank Fill Valves
12. Pipeline Valve Switches
13. Well Flow Controller
14. Well Test Controller
15. Battery Controller
16. Strip Chart Recorder
17. Integrating Flow Meter
18. Plug Valve Actuators
19. Rerun Pump
20. Gas Back Pressure Valve

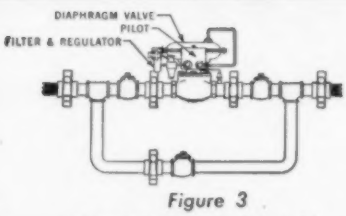


Figure 3

Wellhead Shut-In Control Assembly

THE PHANTO-PUMPER . . .

Is the name BS&B has given to its Automatic Control Systems which perform the following functions:

1. Wellhead Shut-In
2. Well Testing and Data Recording
3. Well Flow Programming
4. Tank Switching

Figure 1 typifies an automatic lease with PHANTO-PUMPER controls. The "nerve center" of any BS&B PHANTO-MATIC Lease System is the group of electrical controllers numbered 13, 14, 15 and 16.

AUTOMATIC WELLHEAD SHUT-IN EQUIPMENT . . . will control any combination of well flowing or pumping conditions. Examples of this equipment are:

1. Excess Flow Shut-In Control Assemblies
2. Hi-Low Pressure Shut-In Control Assemblies (Figure 3 at left)
3. Motor Shut-In Pressure Switch Assemblies
4. Electro-Pneumatic Motor Shut-In Pressure Switch and Control Valve Assemblies.

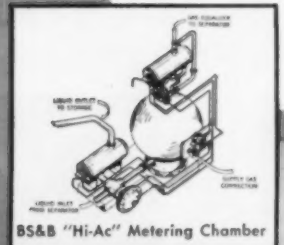
ELECTRO-PNEUMATIC WELL TEST CONTROL EQUIPMENT . . . automatically controls well test programming, routes the flow through test equipment and records test data. Some of the equipment offered as a part of this system includes:

1. Well Test Header and Manifold Assemblies With 3-Way Routing Valves and Master Lease Safety Shut-In Valve.
2. Electrical Well Test Controller With Strip Chart for Recording Well Test Data.
3. Liquid and Gas Metering Equipment, Including Complete Lines of Metering Separators, Metering Chambers, and Metering Treaters.
4. Liquid Sampling Equipment.

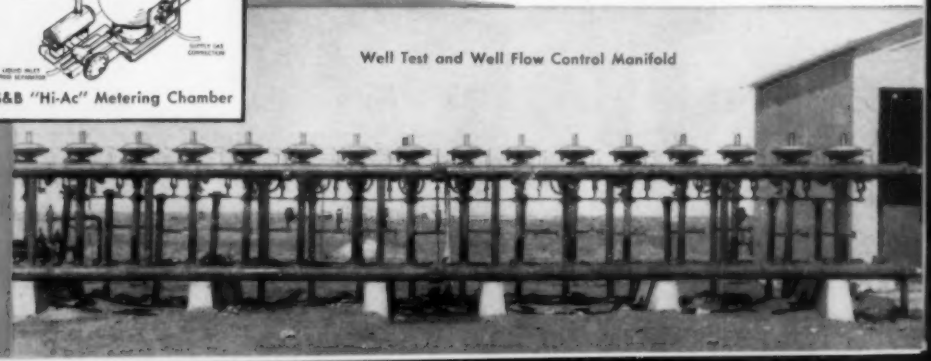
ELECTRO-PNEUMATIC WELL FLOW CONTROL EQUIPMENT . . . automatically programs flow from wells by "stop-cocking" at a central header. Some of the equipment offered as a part of this system includes production header and manifold assemblies with "stop-cocking" valves — or with 3-way routing and "stop-cocking" valves when combined with well test.

Phanto-Pumper Control Panel

PHANTO-SWITCHER ELECTRO-PNEUMATIC TANK BATTERY CONTROL EQUIPMENT . . . automatically fills all tanks to capacity in a pre-set sequence, and automatically by-passes tanks already full or being run to the pipeline. Tanks can be selectively locked out of sequence for cleaning or inspection. If all tanks become full or otherwise unavailable for filling, the controller will automatically shut in system or actuate an alarm circuit.



BS&B "Hi-Ac" Metering Chamber



Well Test and Well Flow Control Manifold

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BS&B PHANTO-MATIC Lease Systems are packaged from a wide selection of equipment components, thoroughly tested under field operating conditions. These systems, when grouped according to function, fall generally into two primary classifications—PHANTO-PUMPER and PHANTO-GAGER.

THE PHANTO-GAGER...

Is the name BS&B has given to its Automatic Control Systems which perform the following functions:

1. Automatic Measurement and Recording of Temperature Compensated Oil Volume in Barrels.
2. Automatic Measurement (or Automatic Sampling and Subsequent Determination) of Quality and Contaminant.
3. Automatic Running of Crude From a Lease Into Connecting Pipeline in Accordance with Predetermined Schedules on an Unattended Basis.

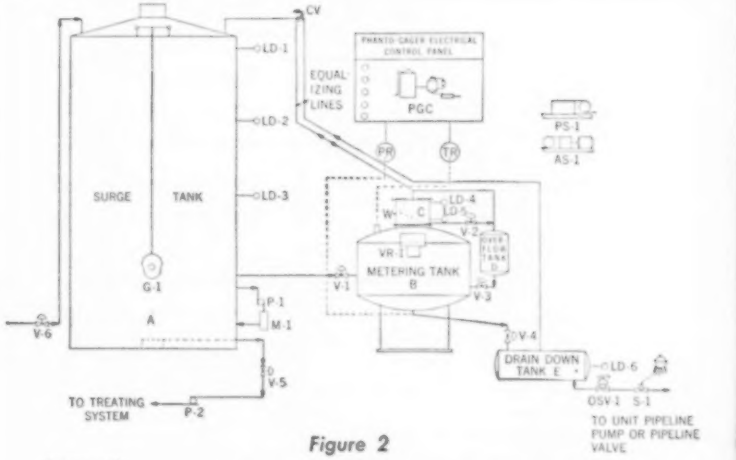

Figure 2

Legend:

LD	— Level Detector	VR	— Temp. Comp. Volume Recorder & Printer	AS	— Air Supply Unit
V	— Valve	TR	— Temperature Recorder	P	— Pump
CV	— Check Valve	PR	— Pressure Recorder	W	— Weir
M	— BS&W Monitor	PS	— Power Supply Unit	C	— Overflow Chamber
S	— Sampler			OSV	— Oil Seal Valve
				PGC	— Phanto-Gager Controller

Figure 2 typifies an electro-pneumatic, volumetric metering tank type automatic custody transfer system. This system is offered in various sizes as a skid-mounted assembly, with single or multiple metering and surge tanks.

Fail-safe controls throughout the system insure that no oil will be lost in case of power failure. Oil cannot be introduced into the metering vessel after the measuring cycle has started, nor can oil be removed from the meter tank (other than to the pipeline) after the top gage has been made and before the run is completed.

For Further Information, Contact Your Nearest BS&B Representative—or Write To...

Phanto-Gager

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Main Guide Posts for a GOOD MANAGER

John W. Newton

A quick answer to the question of what is required of a manager was given me at an early age.

I learned it quail-hunting in the rolling woods of East Texas.

"Son," my father told me one day, right after I'd shot at a quail and missed, "90 percent of all the misses in the world come from shooting at the bird."

The point, of course, is that you've got to lead the target. Constantly focusing on today's problems — and today's only—will most certainly leave you trailing tomorrow.

Hence, forward-looking leadership — coupled with good administration — to my mind forms the very roots of good management. Leadership and administration may sound broad and all-encompassing, but the phrase provides a good starting point for checking into more of the details associated with the expected accomplishments.

What, totally, is required of a manager? My guess is that you have a pretty fair idea of that. Scarcely a day passes without the appearance of worthwhile interpretative essays by advanced students. Professional consultants issue excellent studies and reports. Reprints of addresses by qualified business and industry leaders, informative panel discussions—communications of various types come before you constantly, all shedding light on the many facets of management.

The subject has not been neglected. That fact made me say to myself: "What can I add?"

Well, for one thing, I reasoned, I am a manager. Almost a quarter of a century in that position naturally represents considerable experience—much of it gained the hard way. With that in mind, it seemed that the most effective approach would be to minimize observations on the theoretical aspects of management and to concentrate, instead, on observations chiefly derived from experience.

Here is a selection of the main guideposts. Naturally I don't think the list wraps up the subject once and for all. Indeed, it includes only what appear to be the items of principal influence. Both good and bad results have shown these items must receive regular attention to carry out the managerial assignment.

Of course an effective manager must keep the overall picture before him constantly. He must have a detailed personal knowledge of the men and the major problems facing the organization. By active and up-to-date information and appraisal of results gained through good communications with the plant's key men, the manager can properly evaluate people, methods, and future needs.

The manager must display penetrating curiosity and continuing interest. He must demand that assignments be progressed and completed in orderly fashion. From this he should advance the following primary objectives:

Develop personnel.
Develop organization.
Keep costs at an economic minimum.
Grasp significant technical advancements and their applications.
Maintain good employee and community relations.

Let's consider them, one by one . . .

Revised from a talk before the 29th Manufacturing Group Meeting, Socony Mobil Oil Company, Inc., St. Louis, Missouri, October 4, 1956.

Develop Men

First and foremost, a man who can develop men possesses the major qualification of a manager. This is undoubtedly imperative among objectives being considered by management daily, for it is only through men that any projected goal can be reached.

Organization depends on the men that have been developed.
Keeping costs at an economic minimum depends on those men.
The grasp and evaluation of significant technical developments depend upon them.
And is there any question that relations, both employee and public, depend upon properly developed men?

So this task — the building of men — is the Number One responsibility of a manager. It represents a manager's greatest potential contribution to his company. The need for competent people is growing tremendously and I don't recall a time when the supply exceeded the demand.

Managers should realize, and apparently most do realize, that the shortage can be eased in part by insisting upon organized attention to personnel programs. Well planned and capably administered activities for training, for utilizing known abilities, and for correcting job-qualification deficiencies have proved to be especially worthwhile.

No matter how well-informed or good the intentions, to me, success in developing personnel will depend upon the manager's ability to command sincere personal respect and loyalty through vigorous leadership and fair treatment of his employees.

Develop Organization

Good organization development affects every level of job activity. Functions, responsibilities, and authority need to be expanded or contracted, revised or restated, consistent with the shifts of emphasis on various activities. I doubt that the so-called static organization represents accurate terminology because organizations change with changes in the character of the people in them. By continual alertness the thoughtful manager can accomplish a great deal through the guidance of others, and through them help to insure that any such changes take the desired form and move in the right direction.

Measures of development include improved work performance, both by individuals and by groups; key positions occupied by high caliber men, backed in depth by qualified replacements; communications progressively bettered and effectively employed to coordinate efforts of line and staff units; policies adequately understood and complied with.

Keep Costs Economic

Comment on the cost-control objective doesn't require an attempt at hair-splitting definitions of economic minimum. The manager should be ever conscious of the cost factors which are importantly influenced by his decisions. He must show this consciousness through example. His regard for all such factors will be in harmony with essential purposes of the enterprise. By his attitude, by his actions, others will quickly note the weight he attaches to cost-awareness, and will become his agents in working for lowered costs. This cost emphasis obligates the manager to arrange for systems of control which enable direct, easily-understood comparison of results, both the planned and the actual.

Understand Technical Advances

Improvement of methods, products, and equipment ordinarily moves forward at the pace that associates interpret as being in accord with the manager's feelings. His is the duty, therefore, of creating wide interest in, and requiring adherence to, steps that will steadily advance efforts to become well informed on the application of appropriate technical developments.

It is the manager who is expected to lead in stimulating betterment proposals from all segments of the organization; it is he who should be ready to counsel others on the importance of striking the proper balance between what is needed and what is limiting.

Maintain Good Human Relations

And, finally, let us consider the matter of maintaining the good kind of employee and community relations. Immediately there comes to mind the point that satisfactory employee relations is complementary to the attainment of satisfactory community relationships. I don't mean to imply that a manager whose company has outstanding employee relations may relax while community relations grow better and better. He must work at being a good neighbor. He personally must strive to win the desired position and hold a constructive and a respected role in community life for the plant or operation he heads.

Relations within and outside the business must be worked at continuously, and it is true that good ones with employees provide an extremely important stepping-stone to good ones with the community. From the manager's viewpoint, here, again, is underlined the requirement for extraordinary skill as a leader; here, again is expected great competence as a morale stimulator. These are qualities that foster superior accomplishments and help immensely to cultivate and preserve the best of relationships among men, be they fellow employees or fellow citizens, or both.

Major Factors

Men, organization, costs, technical change, and employee and community relations are the five bench marks I have referred to. They are, it strikes me, the marks of major significance to managers who must determine how best to perform their assignments effectively. They form the fundamentals from which spring the definition earlier given of a good manager: Leadership and administration — leadership that inspires others to work harmoniously toward predetermined objectives; administration that systematically aids the work progress of those so inspired.

Even the most general description of duties and responsibilities readily shows that the successful manager is expected to do many things. To you who are members of the management group, this is neither new nor surprising. But among those many things required of any manager is one I would mention particularly in closing. It is that you are expected to like not only the excellent opportunity which the job presents, but the challenge as well.

* * *

The Author

John Wharton Newton, vice president, director, and manager of refining, Magnolia Petroleum Company, joined the company in 1914. Only two years before, in 1912, he had received his degree in chemical engineering from Texas A&M College. He has held his present position since 1938.

Outside of his highly commendable work as head of his department with Magnolia, he has been a good citizen of Texas and a strong member of the petroleum industry fraternity. So far as Texas is concerned, he is president of the Lower Neches Valley Authority and is a member of the Texas Commission on Higher Education. He is a member of Tau Beta Pi, an honorary society for engineering graduates who are outstanding in industrial and public relations activities. He was the first president of United Appeals.

In the petroleum industry he served during the war as chairman of the refining committee of District III for PAW, and he has been active in American Petroleum Institute and National Petroleum Council. At the present time he is chairman of the API committee on smoke and fumes.

OIC VALVES

MOST COMPLETE MODERN LINE . . .

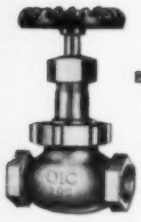

FIG. 520

FIG. 7100

Featuring union type, body-bonnet joint. ⅛″ to 3″. 125, 150, 200, 300 and 350 WSP; 200 to 2,500 WOG.

DURABLE AND SAFE . . .

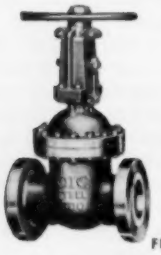

FIG. 3002

FIG. 1572

Excellent for higher temperatures and pressures. 2″ to 16″. 150, 300 and 600 lb. primary pressure series.

29 TYPES, 9 TRIM VARIATIONS . . .

FIG. 1140

FIG. 124

FIG. 333

Includes end-seated seat rings for streamlined flow and longer service. 1¼″ to 16″. 125, 150 and 250 WSP; 175, 200, 400 and 500 WOG. ¼″ to 4″ U-Bolt gates.

1000 BRINELL DURACASE TRIM . . .

FIG. 1021

FIG. 1321

FIG. 1720

Extra-hard, duracase trim, plus your choice of bolted or union type, body-bonnet joint. ¼″ to 2″ gate, globe, angle, check; 600 lb. primary pressure series.

TRIPLE-SEALED AGAINST LEAKS...

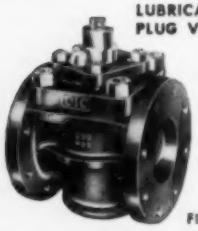

FIG. CR-212

Exclusive design ends shank leakage, holds adjustment, reduces maintenance. ½″ to 12″. Iron, 175 psi to 800 psi working pressures. Cast steel, ASA 150 lb. and 300 lb. pressure classes.

Write for the OIC valve cross reference booklet. It compares valves of 15 manufacturers. Request also new specification literature on the valve lines of your choice.

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FORGED & CAST STEEL, LUBRICATED PLUG, BRONZE & IRON VALVES

Speeds oil field maintenance • construction • material-handling

Consider what the high-speed mobility and *extra capacity* of this Koehring 205 truck crane can mean on your scattered lifting and material handling work around refineries, yards, booster stations, drill sites, etc. It travels anywhere a truck will go — drives 30, 40 miles, or more, in less than an hour's time.

Unrestricted travel

Axle-load distribution of the 205 truck crane conforms with street and highway regulations in most areas, even when carrying 25-foot boom over the steering end. Overall width is 8 feet.

With one of these mobile cranes on hand, you're equipped to lift any load up to 15 tons (based on conservative 85% rating). For high lifts, the pin- or butt-connected crane boom can be extended from 25 to 70 feet. When extra reach is needed, 15 or 30-foot jib can be added to 65-foot boom, for a maximum 95-foot boom-and-jib.

½ to ¾-yard bucket

Heavy lifting capacity and stability of truck mounting increase the 205's work capacity with every attachment. It handles ½ to ¾-yard clamshell bucket on a wide work radius — speeds stockpiling, loading and unloading of coal, chemicals, and other bulk materials.

When there's excavation to be done for new installations, foundation footings, truck-road maintenance, drainage, plant pipeline systems, the Koehring 205 readily converts to dragline, ½-yard shovel or hoe — earns extra savings for you. It's also profitable for "spare-time" rental service to local contractors, cities, and neighboring industries if you like!

Take your choice:

To suit your working conditions, this Koehring 205 is available on a choice of truck, Cruiser®, or crawler mountings. Better see your Koehring distributor about it soon — or write us for more information. Other Koehring sizes up to 95 tons or 3 yards also available.

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Created for military functions in World War II, operations research was coaxed into business and industry as a method of solving company problems. There is some confusion as to the real meaning of OR so here we present

A Many-Splendored Definition of OPSEARCH

MANAGEMENT has come up with many new methods or techniques since the end of World War II. These cover different forms of management — the overall administration, engineering or research management, and operational management. One interesting new method that has for the first time been applied to management is called "Operations Research." Within recent years this type project has received considerable attention all the way from top to middle management.

Like automation when it first engaged the attention of the post-war business world, operations research has many definitions. Perhaps it will be clarifying to collect in one spot a number of these so we can quickly get a multi-faceted view which should help us to a better understanding of OR.

A book, "Operations Research — A Basic Approach," published by American Management Association and edited by Elizabeth Marting, has eight authoritative authors, each with his own definition of OR.

John W. Pocock, partner in Booz, Allen and Hamilton, of Chicago, gives this definition:

"Operations research is a scientific methodology — analytical, experimental, quantitative — which, by assessing the overall implication of various alternative courses of action in a management system, provides an improved basis for management decisions."

Mark C. Lewis, in management consultation services with Geneal Electric, says "the managerial challenge" defines an attitude rather than operations research. "There is an increasing awareness among managers of the validity and usefulness of what might be called the scientific method," he explains. "There is an increasing willingness on their part to accept the risk of investment in the resources, energies, and skills needed in carrying out this work. This willingness, I believe, is born of the recognition that only by such systematic study — that is, the utilization of research methods and attitudes — can they hope to keep the job of simplifying the work of managing in pace with the growth in complexity and scope of the business enterprise."

In his excellent survey of the entire question Glen D. Camp, consultant to the president of Melpar, Inc.,* describes the two words separately. Operations, he says, is any activity in which *responsible authority* utilizes available human and material resources to accomplish a specific *purpose*. Therefore, he continues, operations research becomes a science of generalized strategies and tactics — or more briefly, "research on operations."

In getting a feel for operations research Thomas M. Ware, administrative vice president of International Minerals and Chemicals Corporation, describes the real function of operations research as that of placing in new perspective the relationship of the parts to the whole, which brings into play a scientific approach.

"I like the abbreviated term that found its way into OR discussions: Opsearch," states Ware. "To me it stands not only for operations research, but for *optimum search*. And it also stands for *opportunity search*."

American Machine and Foundry Company has an operations research group headed by Oscar A. Hoffman. He reports that the work of the group is divided into three categories: (1) Laboratory management, (2) Consulting on engineering projects, and (3) Contract work. In laboratory management he points out that one of the difficult things is to know what data might be useful and then find them. In the second category the operations research are essentially acting as consultants to engineering activity. Contract work is to make an analysis of an operation for a potential customer who needs help with writing development specifications.

A comprehensive definition is given by Robert M. Smith, editor of *Office Management*, in the January, 1957, issue. He says "In its broadest sense, operations research might be said to apply the analytical methods of physical science to an economic entity — a company, and by observation of all the activities and influences operating on that company, to determine the chain of cause and effect that exists in each of the company's activities. Just as all the actions and reactions that take place in the physical world can be put in some kind of casual relationship, so presumably can all the major ongoing actions of a small entity — a company in its economic universe."

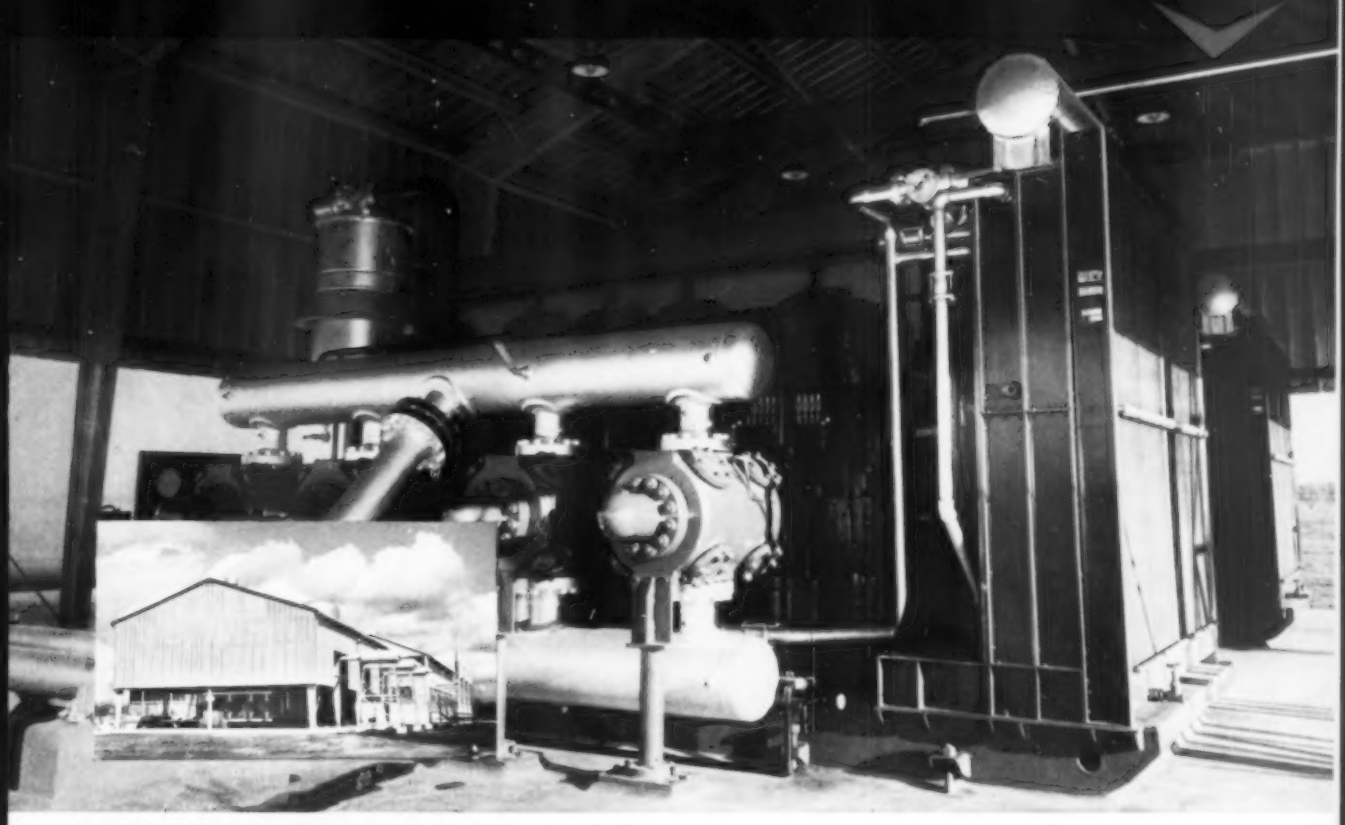
Said A. W. Swan, in *The Engineers*: "Operational research is the investigation of problems which effect management, using whatever scientific methods are appropriate, and resulting in recommendations which lead to executive action."

A good case can be made that automation is simply a development of automatic devices. Operations research, however, is a mathematical method applied for the first time to business administration. Techniques in science are used to make business decisions. In some cases it has been very successful, but there is a long, hard pull ahead during which information must be collected and then patterns of regularities drawn from the collected data when it is reduced to a mathematical formula.

Probably the greatest boost to operations research has been given by the use of new giant computers. Management problems which could not be done by hand computation in a reasonable length of time can now be solved quickly after they are fed into a modern computer. In operations research we have a new approach to management problems — one that promises a larger proportion of success in solving the present-day complex business and industry operations. Part of its present fascination is in the fact that it is a fresh approach that inspires the imagination in what has been routine operation. ★ ★ ★

*Subsidiary of Westinghouse Air Brake Co.

BEAIRD-INGERSOLL-RAND Packaged Compressor Plant



SOUTHERN NATURAL GAS COMPANY's White Castle Supply Line Station, equipped with two Beaird-Ingersoll-Rand 10-SVG 550 h.p. packaged compressors. Shown in inset is the Toca station where three 12SVG, 660 h.p. Beaird packaged compressors have been installed to supplement three large stationary units. Other sizes available from 120 to 660 h.p.

Economical Expansion —

PACKAGED UNITS ADDED TO STATIONARY COMPRESSOR INSTALLATION

SOUTHERN NATURAL GAS COMPANY's growing supply line systems are reaching toward the Gulf on both east and west sides of New Orleans. Pacing this expansion are two new packaged compressor installations boosting the increased gas volume to the main supply line station at Gwinville, Mississippi. The east side line is handled by the enlarged compressor station at Toca, Louisiana. Formerly equipped with three large stationary compressors, this plant has been expanded by adding three 12SVG 660 h.p. Beaird-Ingersoll-Rand packaged units. On the west line a new station at White Castle equipped with two 10SVG 550 h.p. units is offsetting the increased line pressure from Toca station and handling added gas volume.

Southern Natural selected packaged compressors for their expansion program as a result of their field experience. Package units have proved more flexible in service, were more economical to install, required less foundation work and when no longer needed can be almost wholly salvaged. Packaged compressor equipped stations have also been found to be easier and more economical to design for future horsepower additions.

Let us show you how economically Beaird-Ingersoll-Rand packaged compressor plants can be added to your compressor station.

BEAIRD
another AMF product
PACKAGED COMPRESSOR PLANTS

LOWEST COST PER HORSEPOWER INSTALLED

THE J. B. BEAIRD COMPANY, INC.
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Early American Oil Man

The American Indian is credited with many firsts, to which should be added the discovery of oil in America.

True, it was Colonel Edwin Drake, who, in 1859, brought in the first oil well. But long before, the American Indian had learned to skim oil off certain streams that flowed through Pennsylvania.

To the Indians, oil was medicine . . . and although their precise medicinal use may not always have been appropriate, their idea was sound . . . for today oil is actually an ingredient in many drugs.

But far overshadowing its use for drugs and by-products is the use of petroleum to power a growing America . . . petroleum in the form of natural gas . . . petroleum in the form of advanced motor oils, greases, and gasolenes.

Here, above all else, Cities Service is proud to take its place as a leader . . . the only oil company that now offers totally new grades of gasolene for every type of car.

Literally fuels of the future, these new gasolenes are the crowning achievement of the finest men, methods, and multimillion dollar refining equipment. More importantly, they are part of a continuing series of petroleum "firsts" now offered and yet to come from Cities Service . . . for as America grows, so grows Cities Service, for nearly half a century, a leader in oil progress.

CITIES SERVICE

third of a series

Executive-students selected for uniform status and diversification of industry, specialization and location . . . this heightens interest in 12-week course for 50 executives at Stanford

Informal Discussions KEY to Program

Paul E. Holden

DURING World War II Stanford (California) University's Graduate School of Business launched a series of full-time, 12-week courses for mature business executives under the auspices of the Engineering, Science, and Management War Training Program. After the war the heavy influx of GIs which overloaded faculty and facilities pushed the executive development program into the background. It was not until 1952 that the project began once more.

The Stanford Executive Development Program is built around the following objectives:

To develop an expanded consciousness of the political, economic, and social influences which affect the conduct of business.

To develop a top management perspective, an aptitude for considering problems from the viewpoint of the company as a whole.

To develop an acquaintance with an appreciation of other departmental functions, a breadth of vision beyond the scope of the executive's own area of activity.

To develop increased competence in the individual's own field of specialization.

To develop added proficiency in the use of basic management techniques.

There are 10 courses comprising the program, which are: Managerial accounting, personal development, statistical controls and forecasting, management of distribution, personal relations, financial management, top management, employee relations, legal and social relations, and business government relations. The program runs eight weeks — from late June to the latter part of August. Deadline for receiving applications is April 1 of each year.

Enrollment in the course is limited to 50 executives. This permits class sessions to be conducted in a true seminar fashion, with discussion primarily by the student-executives; the instructor functioning essentially as a discussion leader. Average age of the participants so far has been about 45 years, with an average length of business experience about 24 years. Average salary runs between $18,000 and $20,000 a year, exclusive of bonuses and other supplementary compensation.

There are no academic prerequisites for admission and only about 60 percent of the executives who have attended the course have a college or university degree.

The executive-students are nominated and sponsored by their companies and they receive full salary during their attendance and are covered for other expenses. Selection of participants is done with a view to providing a certain level of status on one hand and on the other, diversification as to industries, field of specialization and geographic location. The San Francisco Bay area contains a wide range of industrial and commercial activity and the group has the opportunity to visit outstanding companies where top executives discuss management problems.

The student executives are required to live on the campus in one of the men's dormitories. This allows informal discussions in the evening and added values derive from close and continued association in conferences and bull sessions.

No examinations or written reports are required. The daily work load consists of five hours class session and approximately the same in class preparation. This is in addition, of course, to the informal discussion sessions held in late afternoons, evenings, and weekends.

Once each week a guest speaker, who is a leading executive, takes dinner with the group and meets for a three-hour post-dinner session in the lounge of the dormitory.

The cost for the eight-week program is $1600, which includes a tuition fee of $900, a charge of $150 for books and materials, and a charge of $550 for room and meals.

There are recreation facilities at a nominal fee on the campus and the summer program of the university includes concerts, lectures, and dramatic productions.

Among the 15 members of the advisory committee for the Stanford Executive Development Program are two oil company presidents, T. S. Peterson, Standard Oil Company of California, and R. L. Minckler, General Petroleum Corporation.

Of course, training and development of key personnel has become one of the vital problems to be faced by top level business management. Interest in the Stanford program has shown that management, itself, is vividly aware that action must be taken to prepare executives for advancement to more important responsibility. ★ ★ ★

Professor Holden is director, Executive Development Program, Stanford University, Stanford, California.

MANHATTAN PROJECT TO THE U.S.S. SEAWOLF

CATAWISSA PERFECT SEAL UNIONS HAVE HAD A PART IN EVERY APPLICATION OF

ATOMIC POWER

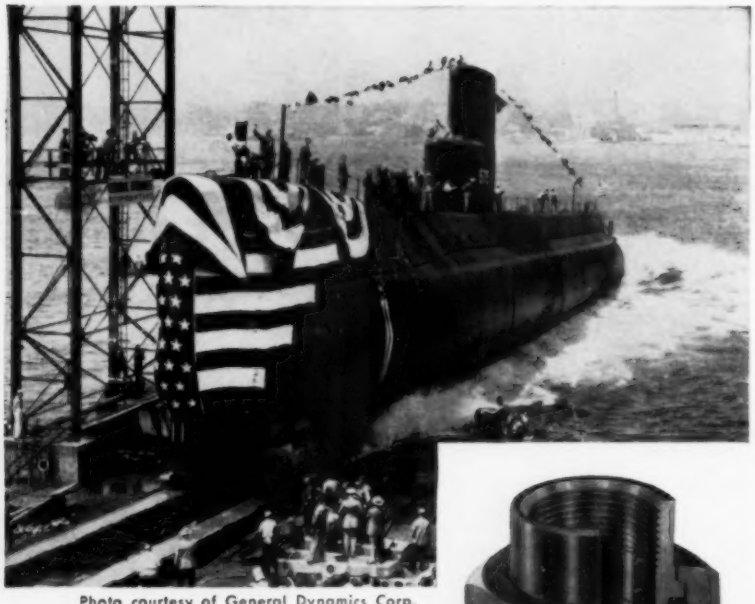

Photo courtesy of General Dynamics Corp.

LAUNCHING THE U.S.S. SEAWOLF at Groton, Conn., marked the development of the second atomic powered submarine built for the U.S. Government. Catawissa Valve & Fittings Co. is proud of its role in the project as major suppliers of Forged Steel Pipe Unions for the "Seawolf" — another repeat order in the atomic field . . . proof positive of satisfactory service!

SAFETY IS A "MUST"

From the original "Manhattan Project" to the U.S.S. Seawolf (and other unannounced atomic developments in private quarters), Catawissa Perfect Seal Pipe Unions have been specified to handle the extreme pressures involved. These are examples of "the toughest jobs", where absolute safety is a "must"!

3-TO-1 SAFETY FACTOR

One of the many extra value features of Catawissa Unions is in the very design itself — a design which gives each union a 3-to-1 safety factor. Catawissa 3000-lb. service unions, for example, are tested to 9000-lbs.; 6000-lb. service unions are tested to 18000-lbs., etc.

This point of superiority, plus expert workmanship and 40 years of experience, make Catawissa Forged Steel Pipe Unions and Swing Check Valves the best buy for rugged, trouble-free service wherever dependable performance is required.

PERFECT SEAL SEATING

Another Catawissa exclusive is its Ball-to-Angle seat design, which assures a Perfect Seal even when the two pipes joined are not in alignment.

ALL PRESSURES, TEMPERATURES

The Catawissa line is the most complete line of unions on the market—regular or special! They're hot forged from solid bars of AISI Spec. C-1026 steel, and meet the requirements of ASTM Spec. A-105, Grade 2.

YOU CAN TAKE THE GUESSWORK OUT OF PIPING PROBLEMS

. . . specify CATAWISSA Perfect Seal Pipe Unions & Swing Check Valves
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LAUGH with BARNEY

Rastus was talking to the doctor after the delivery of his 13th child.

"Rastus," the doc told him, "Mandy shouldn't have any more children — if she does she might die."

"Yassur," Rastus promised. "If we has anymore babies, I'll hang myself from that tree over yonder."

About 10 months later the doctor was back to deliver the 14th baby.

"Rastus," he asked, "do you remember what you promised me the last time I was here?"

"Shore do, doc, I took my rope and a ladder over under that tree. Made a noose and put it over my head and was about to jump off the ladder when I asked myself a question — 'Rastus, is you sure you is hanging the right man?' I couldn't be sure, so I climbed down."

* * *

Sign on Florida highway: Keep Florida Green — Bring Your Money.

* * *

The man who invented the davenport should be a happy man — millions have been made on it.

* * *

A gang of pipeline construction men were way out in the country when they discovered they'd left their shovels at the foreman's shack. They phoned their foreman about the trouble.

He replied: "I'll send the shovels out right away by truck. Lean on each other until they get there."

* * *

After getting her divorce the actress paused on the courthouse steps before the assembled reporters. When one asked, "how do you feel?" she replied,

"I feel like a new man."

* * *

While visiting a rig a man saw a beautiful nude woman running through the pasture. Then three men in white jackets came running up. They asked if he had seen the woman. He replied "yes," and asked what it was all about. One replied "She breaks out of the asylum every once in awhile and we are trying to catch her."

"That's understandable, but why is one guy carrying that bucket of sand?"

"Oh, he caught her last time — that's his handicap."

* * *

Some Indian chiefs recently went to Washington to protest new policies which would remove government protection from their people. They were asked what they thought about the way their affairs were being handled. After a week of hearings and visits to congressmen which accomplished nothing, one brave remarked: "Heap big fertilizer. No crop."

* * *

Progress is wonderful. Each year it takes less time to cross the ocean by plane and more time to drive to work.

* * *

Have you heard about the goat herder's daughter who couldn't get married because she couldn't get anyone to stay with the kids?

Meetings

May 1-3—**API Division of Production,** Eastern district meeting, William Penn Hotel, Pittsburgh, Pennsylvania.

May 6-8—**API,** annual pipeline conference Cleveland Hotel, Cleveland, Ohio.

May 6-8—**American Geophysical Union,** 38th annual meeting, National Academy of Sciences, Washington.

May 9-10—**Conference on Managerial Control,** sponsored by Illinois Institute of Technology, Illinois Institute of Technology Campus, Chicago, Illinois.

May 13-15—**12th Purdue Industrial Waste Conference,** Purdue Memorial Union Building, Purdue University, Lafayette, Indiana.

May 13-16—**API Division of Refining,** midyear meeting, Penn-Sheraton Hotel, Philadelphia, Pennsylvania.

May 14-16—**Industrial Nuclear Technology Conference,** sponsored by Armour Research Foundation and Nucleonics Magazine, Museum of Science and Industry, Chicago, Illinois.

May 16-17—**American Right of Way Association,** 3rd annual national seminar, Conrad Hilton Hotel, Chicago, Illinois.

May 16-17—**API Division of Production,** Pacific Coast district, Biltmore Hotel, Los Angeles, California.

May 19-22—**Texas Independent Producers and Royalty Owners Association,** 11th annual membership meeting, Galvez and Buccaneer hotels, Galveston, Texas.

May 19-23—**ASME,** Oil and Gas Power Conference, Kentucky Hotel, Louisville, Kentucky.

May 20-22—**NACE,** Northeast region spring conference, Syracuse University and Hotel Syracuse, Syracuse, New York.

May 20-24—**American Society for Testing Materials,** 5th conference on Mass Spectrometry, Commodore Hotel, New York City.

May 23-24—**The Society of Petroleum Engineers, AIME,** 3rd annual joint meeting, Rocky Mountain Petroleum sections, Northern Hotel, Billings, Montana.

May 27-28—**Chemical Market Research Association,** annual meeting, Hotel Plaza, New York, New York.

May 27-29—**Rocky Mountain Oil & Gas Association,** Cosmopolitan Hotel, Denver, Colorado.

May 29-31—**12th Annual Short Course in Gas Technology,** Texas College of Arts and Industries, Kingsville, Texas.

June 2-6—**Air Pollution Control Association,** Golden Jubilee meeting, St. Louis, Missouri.

June 2-7—**SAE,** summer meeting, Chalfonte-Haddon Hall, Atlantic City, New Jersey.

June 3-5—**Petroleum Electric Power Association,** annual conference, Herring Hotel, Amarillo, Texas.

June 4-6—**Appalachian Underground Corrosion Short Course,** Morgantown, West Virginia.

June 6—**Pennsylvania Grade Crude Oil Association,** 34th annual meeting, Penn-Sheraton Hotel, Pittsburgh, Pennsylvania.

June 9-12—**AIChE,** Olympic Hotel, Seattle, Washington.

June 9-13—**ASME,** semi-annual meeting, Sheraton-Palace, San Francisco, California.

June 9-14—**API Division of Production,** midyear committee conference, Muehlbach Hotel, Kansas City, Missouri.

June 10-12—**Interstate Oil Compact Commission,** midyear meeting, Canyon Hotel, Yellowstone National Park, Wyoming.

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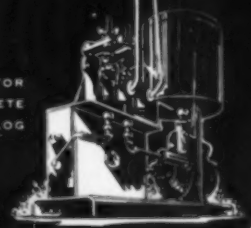
ACCURATE,
CHEMICAL METERING.

MANZEL CHEMICAL FEEDERS are simple in design, ruggedly built, unfailingly accurate. Fully adjustable for metering any desired amount of liquid from 0 to 1 gallon per minute. Our experienced field engineers are at your service.



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NOW *a Modern Fittings Package*

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W-S Forged Steel Fittings are now being shipped in strong, lightweight fiberboard cartons designed to make purchasing a pleasure. Shipments are made up of unit cartons packaged inside a larger reinforced carton. It's easy... and advantageous to order your fittings in packaged quantities.

Here are additional advantages of the new W-S package:

1. Compact and easy to handle.
2. Ideal for neat, efficient stacking on warehouse and stockroom shelves.
3. Sealed against dust and moisture.
4. Contents clearly marked on outside face of each carton, readily visible for prompt identification.

The new W-S package is only one of many reasons why W-S Forged Steel Fittings are the most widely accepted by industry.

Don't forget, too, W-S carbon steel fittings have the additional protection of their new blue synthetic coating. For detailed information on packaged lots ... and for a copy of our new fittings catalog, write today to W-S Fittings Division, H. K. Porter Company, Inc., Roselle, N. J.

Sold Through Leading Distributors

HKP **W-S FITTINGS DIVISION**
H. K. PORTER COMPANY, INC.

June 12-14—**Operations Research Conference,** sponsored by Illinois Institute of Technology, Illinois Institute of Technology Campus, Chicago, Illinois.

June 19-20—**Western Petroleum Refiners Association,** regional technical industrial relations meeting, Broadview Hotel, Wichita, Kansas.

June 19-21—**Association for Computing Machinery,** 12th annual meeting, Campus of the University of Houston, Houston, Texas.

June 23-27—**Canadian Gas Association** meeting, Jasper Park Lodge, Jasper, Alberta, Canada.

June 24-28—**American Institute of Electrical Engineers,** 1957 summer general, Sheraton-Mt. Royal Hotel, Montreal, Quebec, Canada.

July 8-19—**Industrial Statistics for the Process Industries,** short course, sponsored by the Extension Division of the University of Oklahoma and the Chemical Division of the American Society for Quality Control, University of Oklahoma, Norman, Oklahoma.

Aug. 26-28—**Appalachian Gas Measurement Short Course,** 17th annual, West Virginia University, Morgantown, West Virginia.

Aug. 28-30—**International Symposium on Gas Chromatography,** Analysis Instrumentation Committee of the Instrument Society of America, Kellogg Center for Continuing Education, East Lansing, Michigan.

Aug. 30-31—**Association of Desk & Derrick Clubs of North America,** annual meeting, Hilton Hotel, Chicago, Illinois.

Sept. 3-5—**Pacific Coast Gas Association Convention,** San Francisco, California.

Sept. 8-13—**American Chemical Society,** 132nd national meeting, New York City.

Sept. 9-13—**12th Annual Instrument Automation Conference and Exhibit,** sponsored by Instrument Society of America, Cleveland Auditorium, Los Angeles, California.

Sept. 11-13—**National Petroleum Association,** 55th national meeting, Traymore Hotel, Atlantic City, New Jersey.

Sept. 15-18—**AIChE,** Lord Baltimore Hotel, Baltimore, Maryland.

Sept. 23-24—**Steel Founders' Society of America,** 55th fall meeting, The Homestead, Hot Springs, Virginia.

Sept. 23-25—**American Society of Mechanical Engineers,** Petroleum Division, 12th annual Petroleum Mechanical Conference, Tulsa, Oklahoma.

Sept. 26-27—**Western Petroleum Refiners Association,** regional technical-industrial relations meeting, Henning Hotel, Casper, Wyoming.

Sept. 26-27—**Louisiana-Arkansas Division Mid-Continent Oil & Gas Association,** annual membership meeting, Roosevelt Hotel, New Orleans, Louisiana.

Sept. 30-Oct. 2—**American Oil Chemists' Society,** 1957 fall meeting, Netherland Plaza Hotel, New Orleans, Louisiana.

Oct. 1-2—**Texas Mid-Continent Oil & Gas Association,** 38th annual meeting, Texas Hotel, Fort Worth, Texas.

Oct. 6-9—**The Society of Petroleum Engineers, AIME,** 32nd annual fall meeting, Adolphus, Baker & Statler Hilton Hotels, Dallas, Texas.

Oct. 7-9—**American Gas Association,** annual convention, Kiel Auditorium, St. Louis, Missouri.

Oct. 7-11—**American Institute of Electrical Engineers,** 1957 fall general meeting, Morrison Hotel, Chicago, Illinois.

Nov. 11-13—**Steel Founders' Society of America,** 12th Technical and Operating Conference, Carter Hotel, Cleveland, Ohio.

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

PERSONALS

Lieut. Gen. Ernest O. Thompson, senior member of the Texas Railroad Commission, will received the 1957 "recognition award" during the eleventh annual meeting of the Texas Independent Producers and Royalty Owners Association May 19 through 22 in Galveston, Texas. TIPRO President **A. E. Herrmann,** announcing that General Thompson would receive the award, said that, "in reality, the honor we pay the General acknowledges more than his service to the cause of the independent, for the benefits of his devotion to the sound principles of conservation and free enterprise accrue to all of Texas and the nation."

Ohio Oil Company's research center in Denver, Colorado, has added four research scientists to the staff: **Dr. V. Dean Allred** will be an advanced research technologist in the engineering section. He has worked with the Houdry Process Corporation, Catalytic Construction Company and Union Carbide Nuclear Company. **Dr. Robert H. Reitsema** will be a senior research technologist in the chemistry section. He worked with the Upjohn Company and in 1948 became chief chemist with the A. M. Todd Company. **Dr. Charles H. Hewitt** joins Ohio Oil as a research geologist. He was formerly employed by the Sun Oil Company as a field geologist and at the University of Michigan, where he had a teaching fellowship. **Dr. David B. MacKenzie** will also be a research geologist. He was formerly with the American Overseas Petroleum, Ltd.

Landon B. Derby was appointed assistant general manager of The Texas Company's foreign operations department (Western Hemisphere and West Africa). **Henry M. Hanbury** will succeed Derby as manager of the foreign sales division, and **Edwin L. Gorham Jr.** was named manager of the foreign producing division. Derby served as assistant general manager of the foreign sales division prior to his appointment as manager in 1955.

K. W. Brill, Oklahoma City, Oklahoma, was promoted to assistant to **E. F. Battson,** vice president and chairman of the executive committee of Continental Oil Company, with headquarters in New York City. He formerly was central region general manager for Conoco at Oklahoma City.

W. A. Russell will retire June 30 from Seaboard Oil Company due to ill health. He has served the company for over 34 years in positions of responsibility in the accounting and financial departments.

Elliott W. Atkinson, El Dorado, Arkansas, vice president-treasurer of the Lion Oil Company Division of Monsanto Chemical Company, was appointed assistant to the president.

He will assume his new duties June 1, and will move to St. Louis, Missouri.

R. N. Harding has been appointed managing director of Caltex Pacific Oil Company in Indonesia. **A. B. Brown,** former managing director, is returning to service with Standard Oil Company of California after two years with Caltex Pacific. Harding previously was deputy managing director of Caltex Pacific.

DEATHS

Stanley A. Odlum, 41, died suddenly in New York March 15 after a brief illness. He was a vice president of Atlas Corporation.

William Calder, 61, mechanical superintendent of DX-Sunray Oil Company's Tulsa, Oklahoma, refinery died March 27 in Tulsa.

Dr. Hal P. Bybee, 69, professor of geology at the University of Texas, died March 30 at his home in Austin following an extended illness.

James A. Clark, 67, partner in Gardner, Huff & Clark, Seminole, Oklahoma, drilling company, and secretary-treasurer of Luttrell Oil Company, died March 23 in Tulsa, Oklahoma.

Amour Loriaux Sr., 71, Bartlesville, Oklahoma, independent operator, died March 26 in Bartlesville.of a heart attack.

Harry K. Conley, with American Iron & Machine for 15 years, died of a heart attack March 13 at his home in Tulsa.

Walter C. (Pat) Athon, 68, retired Ohio Oil Company pipeline division superintendent at Cody, Wyoming, died recently.

Lewis L. Jones, sales engineer for Mid-States Chemical Company, Inc., of Mt. Vernon, Illinois, was fatally injured in an automobile accident near Troy, Missouri, on March 9.

Harold J. Layden, sales manager at the Kansas City, Missouri, offices of Universal Atlas Cement Company, a U.S. Steel Corporation subsidiary, died March 12 of a heart attack in Oklahoma City.

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Standard tries a flood of fire to make worn out oil fields produce again

Fire flooding produces heat and pressure to boil out previously unrecoverable crude oil, driving it underground to nearby producing wells.

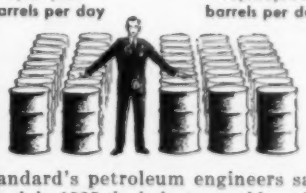
MANY INACTIVE WELLS STILL HAVE LOTS OF OIL left underground in spite of the industry's great advances in oil recovery. Our country must have this oil to meet the growing power needs of industry, the Armed Forces and motorists. That's why Standard is trying a new conservation experiment called "fire flooding."

We ignite some of the oil in a pool . . . control burning by regulating the air supply. Heat and pressure drive the oil to surrounding wells for pumping. It will take more than a year's time and a million dollars to see if fire flooding works. It's worth the effort because it could add more to U.S. underground oil reserves than the discovery of an entire new oil field.

Progress in the West means...

Helping find new sources of oil to supply the 13 million barrels per day the U.S. will need in 1966

1956	1966
8,827,000 barrels per day	13,000,000 barrels per day



Standard's petroleum engineers say, "Back in 1925 the industry could predict only about 20% recovery from a new field. Modern secondary recovery methods, of which fire flooding is one of the latest, could more than double recovery."

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Books to Read

Chemical Engineering Cost Estimation, *by Robert S. Aries and Robert D. Newton, published by McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York 36, New York. Pages, 263. Price, $6.00.*

This book is a practical, quantitative treatment of timely importance and invaluable aid to chemical engineers, chemists, accountants, market researchers, and other executives in industry who are concerned with estimating costs of new units or complete plants as well as costs of manufacturing.

Book's aim is twofold: First, to outline the principles of cost estimation and evaluation, and second, to provide quantitative data for application of the techniques discussed to solving problems encountered in modern industrial practice. Geared to aid management in extracting from project reports the necessary information to prepare an economic estimate, it also serves in helping the engineer or chemist bridge the gap between technical details of the project and economic factors — to give management economic perspective on which the ultimate decision is based.

Believed to be the first single volume to cover the entire scope of cost estimating, its approach is chiefly quantitative in order to provide useful relationships for direct application to problems. The presentation deals individually with each of the components of investment, cost, and profits, and describes methods for their determination. Their interrelationships are shown and their applications revealed. Illustrative problems, charts, and reference sheets are included.

The Chemistry of Petrochemicals. *Published by Reinhold Publishing Corporation, 430 Park Avenue, New York 22, New York. Pages, 267.*

For condensed assembly of pertinent facts of the chemistry and the synthesis of petrochemicals this volume will fill a long-felt want. A fairly comprehensive bibliography is given at the end of each chapter. Subjects covered include syntheses and reactions of paraffins, olefins, diolefins and acetylenes. Aromatics, oxides, alcohols, ketones, aldehydes and acids, esters, amines and nitriles are also included, including good bibilographies of each family.

Equations and reactions are presented in nearly all cases, and also reaction conditions, temperatures, pressures, etc., with yields obtained in many cases. Catalytic oxidation, haolgenation, etc., are phases of the technology and chemistry that are covered at some length, with fairly comprehensive equations and synthesis data. The mechanism of the preparation of organic oxides, or the more complicated aromatic products is discussed not exhaustively but clearly, omitting extraneous information that may confuse the chemical student who may not have wide laboratory or industrial experience.

Altogether the volume is useful as a refresher text and for the academic student who is pointing his efforts toward the petrochemical industry.

Business Fluctuations and Forecasting *by Carl A. Dauten, published by South-Western Publishing Company, Inc., 5101 Madison Road, Cincinnati 27, Ohio. Pages, 518. Price, $5.75.*

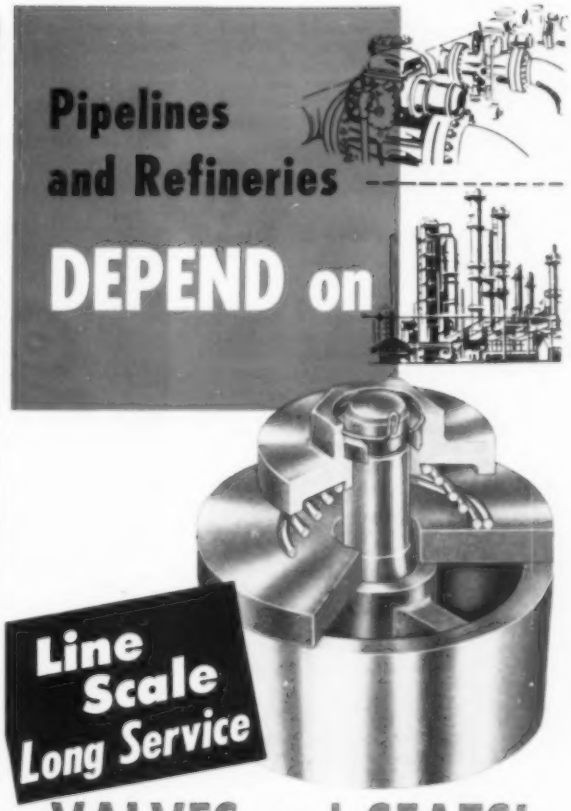
This book provides the businessman with an understanding of business fluctuations so necessary today for sound business decisions, although primarily written as a text for students of statistical forecasting.

In separate divisions, the book deals with: The nature of business fluctuations with emphasis on the cyclical changes within various industries; the statistical methods used in measuring fluctuations; a chronological picture of business fluctuations since 1783; the various theories of the business cycle; and forecasting techniques which includes forecasting for an industry and for an individual business. The latter applies the forecasting theory on a personal basis for the reader's use in a specific business. Numerous illustrations are presented in both graphic and tabular form. Recommended to those responsible for company planning.

Encyclopedia of American Associations, *a business and reference directory, Gale Research Company, 424 Book Tower, Detroit 26, Michigan. Pages, 306. Price, $15.*

More than 5000 associations are listed in six basic sections: (1) Trade, Business, Agricultural and Governmental; (2) Scientific and Engineering; (3) Educational and Social Welfare; (4) Medical and Health; (5) General Associations; (6) Chambers of Commerce (national, state, local and foreign).

Listing for each association includes the address of the national headquarters, executive secretary, number of members and staff, year founded, and a general description briefly outlining membership and purpose of the group. There are, for instance, 48 associations listed under "Engineers," and 14 under "Engineering."



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The Trade PARADE

Anadite Opens Plant in Texas

Anadite, Inc., metal finishing firm, has opened its new plant in Hurst, Texas. The Anadite operation will serve southwestern United States in producing chem-milling and most forms of metal finishing on aluminum, magnesium and steel. It will also produce the Hardas Process, which is another method of hard anodizing. Anadite retains exclusive use of this new process in the United States. Named to head the new facility is Glenn Boehmer, corporate officer of the parent company.

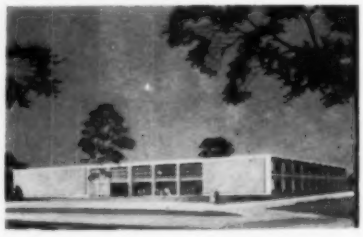
Corporation Combines Divisions

Consolidation of Great Lakes Carbon Corporation's dicalite and perlite divisions into the newly-organized mining and mineral products division has been announced. Purpose of reorganization is to combine the facilities of the divisions for maximum efficiency.

D. Loring Marlett, vice president of the corporation, has been named general manager of the new division. Joseph E. Moran has been appointed assistant general manager.

Shaffer Tool Builds New Shop

Shaffer Tool Works has started construction of an office and warehouse in Houma, Louisiana. The new shop installation will supplement their existing facilities to serve the oil and gas industry for sales and service of Shaffer oil tools for the Gulf Coast area.



Dorr-Oliver Breaks Ground

Dorr-Oliver Incorporated broke ground for a new $2½ million worldwide headquarters in Stamford, Connecticut. The new building will provide 120,000 sq ft of office space for the estimated 550 home office staff members. Target date for occupancy is May 1, 1958.

Rockwell Expands Program

An expanded program of valve research and development has been planned by Rockwell Manufacturing Company's meter and valve division. Included in the enlarged program will be work on automatic lubricators; hydraulic, pneumatic and electric valve operators; coated and high pressure valves; valves for vacuum service; improvement of test methods; and practical methods of producing vacuum-processed metals. The program will be augmented by a new valve laboratory and machine shop at Rockwell's central engineering headquarters at Pittsburgh, Pennsylvania.

'Students' View Houston Plants

A highlight at the School of Production Technology, held twice yearly in Kilgore, Texas, is a field trip to the Houston area where school participants view service company centers and manufacturing plants. The group toured the plants of W-K-M Manufacturing Company, Schlumberger Well Surveying Corporation, and Cameron Iron Works. The 7-week school is sponsored by the American Petroleum Institute and the Petroleum Extension Service of the University of Texas.

Electrical Logging Seminars

Sponsored by Perforating Guns Atlas Corporation, 5 seminars on electrical logging have been conducted by Dr. R. H. Hamilton, noted Tulsa consulting geologist and log analyst.

Dr. Hamilton conducted the highly technical sessions with a free and unrestricted hand to expound his conclusions, completely independent of PGAC or any other well logging service company. Sponsored as a service to the industry, the seminars afforded an unusual opportunity to learn more about the electrical logging services offered by various service companies.

Among the many subjects discussed by Dr. Hamilton were the electrical logging of wells, which now costs operators some $60 million annually, and the new induction logging. The 3-day seminar in Houston, Texas, was attended by an average of 150 geologists and engineers of major and independent oil companies. Other seminars were held in Tulsa and Oklahoma City, Oklahoma, Corpus Christi, Texas, and Lafayette, Louisiana.

WECO's Building Completed

Well Equipment Manufacturing Corporation, Houston, Texas, has occupied its new office and plant. A unique feature of the structure is the use of only 1 row of steel columns down the center of the building to provide 2 clear spans of 100 ft. The 64,000 sq ft plant is completely air-conditioned. Well Equipment Manufacturing Corporation, division of Chiksan Company, is a subsidiary of Food Machinery and Chemical Corporation.

Brussels Computation Center To Be Opened

An analog computation center will be opened in Brussels, Belgium, during the early summer of 1957 by Electronic Associates, Inc. The center will provide the very latest types of electronic analog computers as well as a staff of scientists for problem analysis and programming. The equipment and staff of this center will be available for rental on an hourly, weekly, or monthly basis to the various companies in Western Europe.

In announcing the establishment of the center, Lloyd F. Christianson, president of Electronic Associates, Inc., said, "We feel that there is a growing need in industry for a facility such as we will establish in Brussels. It will prove particularly beneficial to the smaller companies which have not yet found it feasible to invest in their own computation facilities. One of the purposes of this center is to educate business and industry on the capability of analog computers to economically solve many of their problems with an enormous saving of time and money."

To each problem, the center will assign the necessary scientists, engineers, or mathematicians experienced in the use and applications of analog computers to evaluate, set up, and solve problems submitted. The plans are to staff the center with as many European scientists as possible.

PEOPLE

Erwin F. Burnett, formerly assistant to manager, commercial research, has been appointed manager of the commercial research section of U. S. Steel's Oil Well Supply Division.

Walter C. Byrne, Jr. is now sales manager of Microwave and Industrial Control Department of Motorola.

Ted C. Lemcke and **John G. Orton** have been named special sales representatives for Reed Roller Bit Company.

Earle S. Ebers has been appointed assistant general manager of the Naugatuck Chemical division, United States Rubber Company. **Harold M. Parsekian** has been named general sales manager.

W. H. Riggins has been named export sales representative for Hydril Company.

Leon D. Richardson has been appointed assistant general sales manager of Eutectic Welding Alloys Corporation.

J. W. (Mutt) Caskey, formerly district manager, is now assistant division manager at Casper, Wyoming, for Houston Oil Field Material Company, Inc. **A. N. MacDiarmid** has assumed duties as assistant division manager in San Antonio.

Ralph G. Greer was appointed manager of sales, construction equipment division, International Harvester Company.

James V. O'Leary has been named general sales manager for Commercial Solvents Corporation. He will be responsible for sales of all of the company's products which are marketed through 5 departments.

Robert C. Booth, formerly representative for the company's Houston sales area, will be general manager of Plastic Applicators' new Odessa, Texas, plant.

Albert R. Kaspark has been appointed manager of technical sales for Wolverine Tube, Division of Calumet & Hecla, Inc.

Cameron Iron Works, Inc. has promoted **W. L. Reynolds** from manager of the Mid-Continent district at Tulsa to a staff assistant to the sales manager in Houston. **Radean Hallmark** was named district manager replacing Reynolds. **Roy Uhl** is now manager of the Tulsa sales office.

Power Specialty Company has appointed **Walter J. Verlander** manager of its newly established New Orleans office.

Robert H. McLemore has been elected president of Otis Engineering Corporation.

R. L. Collister is now manager of equipment insulation sales of the insulation division, Armstrong Cork Company. He succeeds **L. E. Cover** who has retired.

Roger R. Reynolds has been named district sales manager for the Texas, Oklahoma, and Louisiana territory of Yale Materials Handling Division, The Yale & Towne Manufacturing Co.

John C. Wallace has been named vice president of engineering for the Walworth Company, and **Frederick M. Jackson** has been named vice president in charge of sales.

Thomas Beard has been appointed vice president in charge of sales for the recently reorganized Atlas Exploration Co. of Houston, Texas.

Chain Belt Company has appointed three new regional managers and six new district sales managers. Eastern regional manager is **J. B. Roberts. William Sivyer** is midwest and southern regional manager and **H. F. Bergis** will be northwestern regional manager. District sales managers and their offices are **J. S. Moore,** New York; **Harold M. Weil,** Philadelphia; **D. P. Murrill,** Atlanta; **W. E. Church,** Portland, Oregon; **F. R. Traylor,** Charlotte, North Carolina, and **C. D. Bergen,** East Orange, New Jersey.

J. H. Johnson has been appointed sales engineer for Tod Pazdral Pipeline Specialties of Houston, Texas.

A. R. Kratzberg, formerly general superintendent, has been named manager of Fluor Products Company's metal fabrication division at Paola, Kansas.

Fritz Higgins has been named sales representative for Johnston Pump Company in the Great Lakes area.

James E. Iliff has been appointed vice president-general manager of Davidson-Kennedy Associates Company. He will direct the Chicago office, specializing in the design, procurement of equipment, and erection of chemical process plants and facilities.

R. P. Dunford is now a sales engineer for Welex Jet Services, Inc., in the Stillwater, Oklahoma, district. **Jack B. Cross** was named sales engineer for the Wichita Falls, Texas, district.

Eight department heads have been named to administer the engine division of Caterpillar Tractor Co. They are: **K. J. Zerwekh,** chief accountant; **E. H. Spaulding,** employee relations manager; **Randall Roman,** chief engineer; **L. F. Redenius,** manufacturing manager; **W. N. Foster,** market services manager; **R. D. Norris,** purchasing agent; **J. H. Gill,** sales manager and **W. E. Irwin,** service manager.

Harry Haines, former associate editor in charge of the Houston office of the Chemical and Engineering News, has been named petrochemical contract engineer for the Walter Kidde Engineers, Southwest, Inc.

Charles F. Radley has retired as director of publicity and a member of the Oakite Products, Inc. board of directors. However, he will continue as a consultant on advertising, public relations, and general management policy.

Douglas R. Hortvet has been appointed chief engineer of the A. O. Smith Corporation of Texas.

Halliburton Oil Well Cementing Company's new manager of safety is **Harry B. Ziegler.** He succeeds **Irby B. Cate,** who retired recently. **J. I. Jordan** fills the new position of assistant manager.

Four new district offices have been established by Weatherford Oil Tool Company. Managers are: **Robert F. Kercher,** Great Bend, Kansas, district office; **Tom McClelland,** Lake Charles, Louisiana, district office; **J. T. Liner,** Hobbs, New Mexico, district office, and **Charles C. Copeland,** Farmington, New Mexico, district office.

Glenn Clark has been transferred to Lafayette, Louisiana, where he is now district manager for the Gulf Coast area of Hycalog, Inc. **H. K. Ware** has been transferred to Jackson, Mississippi, to replace Clark as district manager.

Paul K. Eckhardt is now manager of the general apparatus sales department of Union Switch & Signal Division of Westinghouse Air Brake Company. He has held several supervisory positions with the company, the latest being section engineer.

P. K. Eckhardt

A. J. Williamson

The board of directors of Tube Reducing Corporation has elected **A. J. Williamson** president.

M. L. Talbert has been named chief engineer for Security Engineering Division, one of the Dresser Industries. Talbert replaces **Carl Lichte,** who was appointed to the staff of the turbodrill division of Dresser Industries, Inc. Talbert will coordinate field and plant engineering activities.

Dr. William P. Hettinger Jr. has been named research director for the catalyst division of National Aluminate Corporation.

Raymond E. Burton, assistant sales manager for Koehring Company, has been appointed to the new post of assistant director of marketing.

A. J. Broggini is now president of the Badger Manufacturing Company. He succeeds **George C. Hargrove** who is retiring from active service. In addition to his new duties, Broggini will continue as chairman of the executive committee.

A. J. Broggini

H. E. Hester

Harry E. Hester has been appointed executive assistant to the president of McCullough Tool Company. He will aid the president in all phases of company operations.

Elmer A. Trask has been named Cleveland district manager, wire rope and aircord division, for John A. Roebling's Sons Corporation. Trask succeeds **Earl A. Frazier,** who now heads wire rope and aircord sales at Roebling's New York district office.

Paul R. Hoffmann of Lilie-Hoffmann Cooling Towers, Inc., St. Louis, Missouri, has been elected president of the Cooling Tower Institute. Hoffmann is president of his company and has served on the board of directors of the Institute since 1950. He succeeds **James P. Wiseman** of the Fluor Products Company, Whittier, California. Other officers elected for 1957 terms at the recent CTI board meeting were: **Karl E. Johnson,** vice president; **Denis E. O'Neil,** secretary, and **Forrest B. Reed,** treasurer.

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Trade Parade

18 Sessions — 799 'Brainstorms'

Tube Turns Division of National Cylinder Gas Company is doubling the size of its main plant. Expansion plans were evolved in a series of brainstorming sessions. (Term "brainstorming" describes a group creative thinking process.) In 18 such sessions, the employees submitted a total of 799 ideas, and many of these have been adopted in the company's program.

In the brainstorming meetings, a plant layout board with proposed buildings and machines scaled down to a quarter of an inch were available for inspection. Participants were urged to let their imagination soar. All ideas were welcomed at the meeting and criticism or weighing of ideas was barred. Afterward the ideas were evaluated and the many good ones turned over to the company's management and engineering staffs for incorporation in expansion plans.

Republic Has Special Services

Republic Supply Company of California announces a new pipe department with a program of special services. These services include consultation with buyers on pipe specifications, coating and wrapping, cement lining service, cutting and threading, and grooving for victaulic coupling. New department is under the direction of J. G. Anderson.

Silicon Improves Infrared Use

Optical parts of pure silicon material have been developed by Raytheon Manufacturing Company which allow infrared analysis on low temperature samples. Present materials require a warmer source for equal sensitivity. It is anticipated that new optical part will extend range of infrared use in refinery analysis as well as aid in identifying new compounds in the synthetics field.

Schramm Opens New Division

Schramm, Inc., manufacturers of air compressor equipment, opened an oilfield division in Dallas, Texas. New operation was established in order to concentrate the company's engineering, sales, and service operations in the oil country. Headed by Philip L. McLaughlin, the division will function as a separate branch of the parent company, but will utilize some of the existing dealer and sales organization facilities of the manufacturing firm.

Standard Enters New Field

The Standard Tube Company of Detroit, Michigan, is entering the oil well tubing manufacturing field. Upsetting, threading, and testing equipment has been installed, and an additional electric resistance welding mill, capable of producing 2-in. tubing to 5½-in. 14 lb casing, is being installed. For the present, production will be confined to 2⅜ in. 4.7 lb EUE threaded and coupled J-55 tubing.

Du Pont Ship Begins Service

The first ship to transport tetraethyl lead in bulk has gone into service. Reconditioned for Du Pont, it is equipped with 14 upright cylindrical pressure vessels for ethyl chloride and 6 special steel tanks for tetraethyl lead. Unusual feature is that it is equipped with unloading arrangements with swingline connections mounted on board ship.

Chemical Manufacturing Business Purchased

Minnesota Mining & Manufacturing Co. has purchased the KEL-F chemical manufacturing business from The M. W. Kellogg Company, a subsidiary of Pullman Incorporated. Minnesota Mining & Manufacturing will take over the KEL-F manufacturing facilities adjacent to Kellogg's Jersey City steel fabricating plant and research laboratories. Sale will not effect the M. W. Kellogg petroleum and petro-chemical research laboratories or other Kellogg manufacturing activities.

Plant Produces Cement

Newly installed equipment in the West Warren, Massachusetts, plant of Haveg Industries has the capacity to produce 55,000 lb per day of Haveg 7010 cement, a silica filled polyester resin composition with properties not found in any other chemical mortar. Haveg 7010 has been developed for use with brick and tile tank linings and for laying floors and walls in chemical processing areas.

NEWS NOTES

CELANESE MEXICANA, SOUTH America, an affiliate of Celanese Corporation of America, has started construction of a new chemical plant near Mexico City for the manufacture of formaldehyde and the formulation of synthetic resins derived from that intermediate raw material. The planned production of formaldehyde marks the entry of Celanese Mexicana into the chemical producing field.

FORMATION OF RESEARCH-COTtrell (Canada) Limited has been announced. Offices of the new company are located in Toronto.

DIAMOND ALKALI COMPANY HAS announced plans for constructing a new plant to produce 50-million lb of vinyl chloride monomer annually. New plant will be located at Diamond's Deer Park plant in Houston, Texas.

FOUR WHEEL DRIVE AUTO COMpany, manufacturer of 4 and 6-wheel-drive trucks, has opened its new branch sales and service center at Duncan, Oklahoma.

AMERICAN POTASH & CHEMICAL Corporation is constructing a $5,000,000 chemical manufacturing plant at Aberdeen, Mississippi, for the production of sodium chlorate. Initial production at the Aberdeen plant will be at the rate of 15,000 tons of sodium chlorate per year, with provisions for possible future expansion into other chemical fields.

M. J. CROSE MANUFACTURING CO., Tulsa ,Oklahoma, has purchased the complete facilities of Cinch Pipe Bending Co. of Houston, Texas. Plant is designated the Cinch Division.

HEADQUARTERS FOR HUGHES Tool Company's western region has moved from Midland, Texas, to the Vaughn Building, Dallas.

AUTOMATIC TEMPERATURE CONtrol Company is preparing to move into its new plant in King of Prussia, Pennsylvania. The move to the new location is planned for July or August of this year.

J. L. Heath has been appointed manager of the Oklahoma division of Schlumberger Well Surveying Corporation. He succeeds **L. A. Puzin** who has been made chief engineer of overseas operations. **Charles B. Evans** is the new northern Rocky Mountain division manager and **Guy B. Sullaway** has been promoted to division sales engineer for the Texas Gulf Coast division.

Ardon B. Judd has been elected president of Southwest Fabricating & Welding Company, a subsidiary of Walworth Company. **Fred W. Belz,** president of the parent company, becomes chairman of the board of Southwest.

Earl Erich has been appointed sales manager of Tube Turns Plastics, Inc.

Earl Erich

C. B. Ames

C. B. Ames has been named president of the Fish Engineering Corporation. **Ray C. Fish** became chairman of the board.

WHEELING
COUPLINGS
FOR OIL COUNTRY USE
LINE PIPE COUPLINGS A.P.I.
⅛" to 12" — Seamless — Black or Galvanized
PLAIN TUBING COUPLINGS A.P.I.
1" to 4" — Seamless
EXTERNAL UPSET TUBING COUPLINGS A.P.I.
¾" to 3½" — Seamless
CASING COUPLINGS A.P.I.
4¼" to 13⅜" — Seamless — Long or Short
HYDRAULIC COUPLINGS
⅛" to 4" — Seamless
REAMED AND DRIFTED A.I.S.I.
¾" to 12" — Seamless
DRIVE PIPE COUPLINGS
6" to 12" — Seamless
TOP QUALITY Since 1918
Sales Offices In Leading Cities:
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Baltimore, Md.—William H. Thurlow, 2301 No. Charles St.
Chicago, Ill.—Harry A. Jay, Suite 1090, Old Colony Bldg.
Denver, Colo.—Earl H. Jones & Co., 1863 Wazee St.
Detroit, Mich.—R. W. Lang, Jr., 505 Park Avenue
Erie, Pa.—R. J. Maggi, Box 711
Falmouth, Mass.—Walter S. Bennett, 53 Minot St.
Grand Rapids, Mich.—R. W. Lang, Jr., 138 Burton SE
Houston, Texas—Henry H. Paris Distributor, Inc., Box 932
Independence, Mo.—Craig A. Fross, 3701 Norwood
Los Angeles, Cal.—James A. Riordan Co., 1400 Santa Fe Avenue
Louisville, Ky.—Sid. Schultze Co., 514 W. Main St.
Milwaukee, Wis.—W. G. Nelson, 3347 N. 97th St.
Narberth, Pa.—J. W. Worthington, 105 Forrest Ave.
Newark, N. J.—Ira L. Rothenberg & Assocs., 398 Market St.
New York, N. Y.—Max Rothenberg, 11-05 38th Ave., Long Island City
Omaha, Neb.—Wm. Freiden, Central States Engineering & Sales Co., 5101 Blondo St.
Oswego, N. Y.—Northeastern Associates, Inc., Neil Chatterton, Secretary, P. O. Box 284
Portland, Ore.—Earl H. Jones & Co., 1233 NW 12th Ave.
Richmond, Va.—P. C. Abbott & Co., 15 E. Franklin St.
St. Louis, Mo.—Walter C. Dallinger Co., 4869 Goodfellow St.
Seattle, Wash.—Earl H. Jones & Co., 819 Thomas St
WHEELING MACHINE PRODUCTS COMPANY
WHEELING, WEST VIRGINIA
Factories at WHEELING, W. VA. and WOODLAKE, CALIFORNIA

Trade Parade

Dr. David H. Morgan, former president of Texas A&M College, has been appointed director of college relations for Dow Chemical Company.

Howard A. Bach, formerly assistant sales manager, has been promoted to sales manager of Lagonda Division, Elliott Company.

G. A. Walley is chief engineer in charge of newly-opened Alhambra, California, manufacturing facilities of Panellit, Inc.

The Hillmac Corporation, Diamond Coring Specialists, has appointed **Giles Acker, Jr.** district manager of the El Dorado, Arkansas area.

Reginald L. Johnson has been elected vice president of Johns-Manville Sales Corporation.

Ray G. Taylor, Jr. has been named to the newly-created post of manager of engineering in the recently consolidated Oilfield Products Engineering Department of Byron Jackson Division. He will also supervise Byron Jackson field engineers.

Frank B. Gray, Jr. has joined the Caran Engineering Corporation as chief engineer in charge of spectrometric well-logging division.

John L. Mangan has been appointed manager-industry sales for General Electric Company's gas turbine department.

C. Dana McCoy, former international director and New York manager of the Rust Engineering Company, has been appointed international director of Badger Manufacturing Company.

John H. Morava was appointed president of United States Steel Supply Division of the United States Steel Corporation. The supply division merchandizes a wide variety of steel products.

J. E. Smith, vice president of Johnston Testers in Houston since 1951, has been named president of the Hutchison Manufacturing Company of Houston.

J. E. Smith

A. M. Birnie

A. M. Birnie has been advanced to executive vice president for Security Engineering Division. Formerly vice president and general sales manager, he will continue in his capacity as general sales manager and also assume the responsibility for field engineering activities.

Bob Cadenhead is now mid-continent district sales manager for Win-Well Manufacturing Company.

H. E. Fellows has been appointed manager of the power chief engine department of Nordberg Manufacturing Company. **G. B. Wright** has been named district manager of the company's Great Lakes territory.

R. T. Wade has been named technical assistant to the vice president of field operations for Schlumberger Well Surveying Corporation.

C. Y. Vallance is now district superintendent of Baroid Division, National Lead Company.

Vander V. Gunn, manager of South American subsidiaries for Halliburton Oil Well Cementing Company, is moving from Duncan, Oklahoma, to Maracaibo, Venezuela.

R. L. Morris, formerly manager of the Mississippi division for Schlumberger Well Surveying Corporation, has been assigned to Shreveport as manager of the North Louisiana division. **J. D. Austin** is new manager of Schlumberger's district at Great Bend, Kansas, while **J. L. Hallman** assumes that position at Farmington, New Mexico.

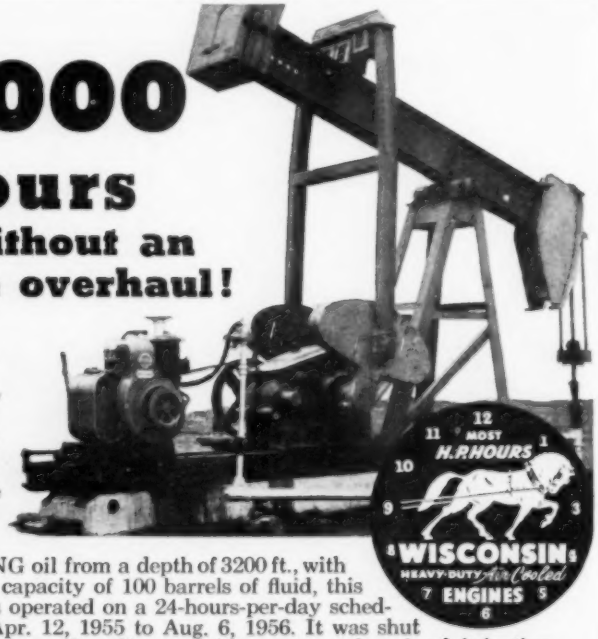
R. L. Morris

C. E. Bogle

A new wire rope section has been incorporated into the sales organization of Jones & Laughlin Supply Division at its Tulsa, Oklahoma, headquarters office. **C. E. Bogle** is manager of wire rope section.

Arthur I. Coyle has joined the drilling mud sales staff of Minerals & Chemicals Corporation of America.

11,000 hours without an engine overhaul!



● This Model TFPD Wisconsin Air-Cooled Oil Well Pumping Engine was operated practically continuously for a total of 11,000 hours (the equivalent of approx. 75,240 hp. hours, operating at 1800 rpm., 60% loaded) . . . verified by the sworn statement of the supervising oil field foreman.

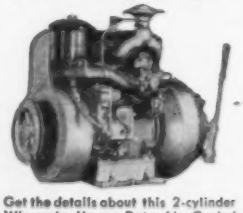
PUMPING oil from a depth of 3200 ft., with a daily capacity of 100 barrels of fluid, this engine was operated on a 24-hours-per-day schedule from Apr. 12, 1955 to Aug. 6, 1956. It was shut down only for such ordinary maintenance as changing lubricating oil, spark plugs and magneto points.

When this engine was brought to the shop for inspection and possible repairs, after its grueling 11,000-hour oil well pumping assignment, the shop mechanics were surprised to find the valves in excellent condition, needing only slight grinding. Piston pins were not worn enough to need changing and cylinder walls were still in condition to permit the use of standard rings. Even the connecting rods showed practically no wear. After minor repairs the engine was put back on the job, pumping the same well, and is still going strong!

Here is tangible proof of Wisconsin Engine heavy-duty stamina and basic *High Quality* design and construction in all details . . . including such features as tapered roller main bearings, Stellite exhaust valves and valve seat inserts, in combination with positive type valve rotators, and many other outstanding service advantages.

You can't do better than to specify "Wisconsin Power" for your equipment.

Model TFPD Wisconsin Oil Well Pumping Engine



Get the details about this 2-cylinder Wisconsin Heavy-Duty Air-Cooled Oil Well Pumping Engine, with built-in HIGH MOMENTUM FACTOR.

WISCONSIN MOTOR Corporation
MILWAUKEE 46, WISCONSIN
World's Largest Builders of Heavy-Duty Air-Cooled Engines

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805 SOUTH MAIN STREET • WICHITA, KANSAS
OIL FIELD DISTRIBUTORS FOR WISCONSIN ENGINES AND ALL TYPES OF UTILITY UNITS

A7-6071-½-I

Trade Parade

Phil Griffin has been named manager of sales and advertising for Johnston Testers, Inc. Griffin replaces **J. E. Smith,** who has accepted the presidency of the Hutchison Manufacturing Company.

Phil Griffin

C. J. Folger

Charles J. Folger, formerly regional manager for Orbit Valve Company over the mid-continent and eastern states area, has been promoted to manager of industrial sales.

Glen A. Tableman has been appointed assistant to the vice president-marketing of W-K-M, division of ACF Industries, Incorporated. He will be in charge of special projects.

G. A. Tableman

E. W. Upton

Edward W. Upton has been appointed executive assistant to the president of The Refinery Engineering Company, a division of Vitro Corporation of America.

Howard A. Reid, formerly service representative in Texas and Mississippi, has been appointed export sales representative for Technical Oil Tool Corporation.

H. A. Reid

P. P. Percich

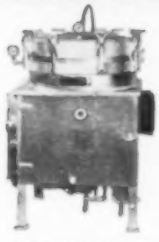
Philip P. Percich has been appointed assistant manager of Goodyear Tire & Rubber Company's hose sales department.

Ralph E. Kramer has been named executive vice president in charge of general operations and sales for Hammond Iron Works Company.

Walter Donner has been named assistant director of research and engineering for laboratory instrumentation for the scientific instruments division of Beckman Instruments, Inc.

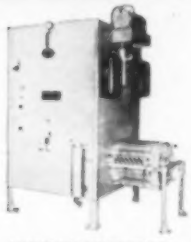
Donald A. Fitch has been appointed assistant manager of pipeline sales for U. S. Steel's National Tube Division. He will be responsible for coordinating sales of trunk pipeline products.

HILCO LUBRICATING and INDUSTRIAL
Oil Maintenance Equipment
Saves Your Oil, Money and Machinery



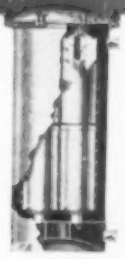
OIL RECLAIMER

For continuous oil purification in range of 2-100 gph. Removes all solids, acids and volatile contaminants.



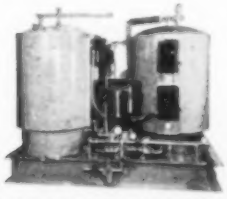
PURIFIER-RE-REFINER

For all purification in batches of from 8 to 100 gallons. Removes all solids, acids and volatile contaminants.



FILTER

Furnished in capacities from 0.1 to 750 gpm. Various cartridges available for mineral and inhibited detergent oils.



HIGH CAPACITY RECLAIMER

Combines filtration for removal of solids and sludge with vacuum vaporization for removal of solids, acids, water, solvents, fuel dilution. Furnished in standard or custom built models to 600 gph.

HILCO purification means *complete* oil purification . . .

Whenever oil is used it becomes contaminated and must be discarded or conditioned for further use. There is a HILCO to do this job for you. You can recover large quantities of oil at low cost. HILCO units are available for continuous or batch operation.

A COMPLETE LINE OF EQUIPMENT FOR RECLAIMING, FILTERING, PURIFYING AND REFINING OIL FROM . . .

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- Tractors
- Gasoline Engines
- Gas Engines
- Automobiles
- Buses
- Heat Treating Systems
- Locomotives
- Steam Turbines
- Steam Engines
- Air Compressors
- Vacuum Pumps
- Transformers
- Circuit Breakers
- Wire Drawing Machines
- Hydraulic Equipment
- Metal Rolling Mills
- Paper Making Machinery
- Oil Bath Oil Air Filters

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• CONSULTING ENGINEERS •

WRITE TODAY! FOR THE NEW HILCO CATALOG FOR COMPLETE INFORMATION AT NO OBLIGATION . . .

THE HILLIARD Corporation

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ELIMINATING CONDITIONS DANGEROUS TO EMPLOYEES

As part of its never-ending effort to improve its service to employers in Texas, the Texas Employers' Insurance Association maintains one of the most complete Industrial Hygiene laboratories in the Southwest. Generally analyzing elements and compounds used by industries . . . Identifying unknown materials . . . Determining flash and fire points of hazardous substances . . . Analyzing the very air workers breathe to prevent occupational diseases . . . These are but a few of the activities carried on in this laboratory to help Texas industries discover and eliminate conditions dangerous to the health and safety of their workers.

This is one of the many services offered by the Texas Employers' Safety Engineering Division. It's only one of the methods of ensuring safer working conditions and reducing accident costs. And it is one more reason Texas Employers' is the undisputed leader in the field of Texas workmen's compensation insurance. Are you taking advantage of the **SERVICE** and **SAVINGS** offered by Texas' largest writer of this coverage?

For full information, call or write our nearest service office listed below, or write direct to:

Symbol of leadership in
WORKMEN'S COMPENSATION
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Outstanding opportunities in Sales, Claims and Engineering for qualified young men.

TEXAS EMPLOYERS Insurance Association

A. F. ALLEN, Chairman of the Board
BEN H. MITCHELL, President

HOME OFFICE Employers Insurance Building DALLAS, TEXAS

Service Offices: ABILENE • AMARILLO • AUSTIN • BEAUMONT • CORPUS CHRISTI • DALLAS • DALLAS (Oak Cliff) • EL PASO • FORT WORTH • FREEPORT • GALVESTON HARLINGEN • HOUSTON • LUBBOCK • MIDLAND • ODESSA • PORT ARTHUR • SAN ANGELO • SAN ANTONIO • SHERMAN • TYLER • WACO • WICHITA FALLS

TYPE 657A

Double port globe body for conventional service. Also supplied single port where tight closure required. Normally supplied in iron or steel in sizes ½" thru 12".

TYPE 657YY

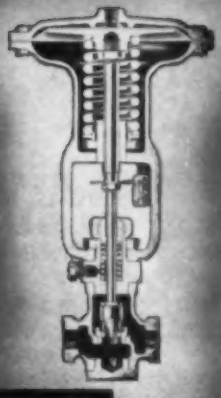
Three-way control valve for by-pass or blending service. Eliminates need for two globe type control valves. Available all castable alloys sizes ½" thru 12".

FISHER®

Has the control valve for your plant

TYPE 667Z

Split type body in which parts are readily accessible; can be economically supplied in various alloys for corrosive service. Available in flanged sizes ½" thru 2".



TYPE 510G

Small and compact bronze control valve for relatively light service. Available in screwed sizes ½", thru 2".

TYPE 657-458

Angle control valve for handling fluids containing solids, or flashing liquids which are erosive. Normally supplied in steel flanged ends in sizes 1" thru 6".

TYPE 657–SAUNDERS

Fisher operator on Saunders patented valve is widely used on "hard to handle" fluids which are viscous and/or corrosive. Available in wide variety of materials in sizes ½" thru 6".

Special design bodies for process services

Wide selection of sizes and available in all castable alloys

Supplied with improved diaphragm operator that provides accurate valve response

FISHER GOVERNOR COMPANY • MARSHALLTOWN, IOWA

CANADIAN PLANT: WOODSTOCK, ONTARIO

LEADS THE INDUSTRY IN RESEARCH FOR BETTER PRESSURE AND LIQUID LEVEL CONTROL

...for straight right-angle cuts every time...the new

RIDGID

Wide-Roll Pipe Cutter

fast true pipe cuts on your power drive

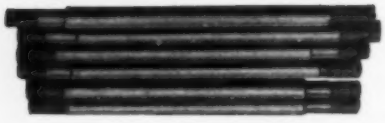
Rolls are twice the usual width, double the bearing surface on pipe—sure straight start of cut . . . by hand or power drive—extra fast and easy. Pays you to see it before you buy your next cutter—at your Supply House.

No. 201, ⅛″ to 1¼″
No. 202, ¼″ to 2″

The Ridge Tool Company, Elyria, Ohio, U.S.A.

RIDGID
Work-Saver Pipe Tools

Pump rods hard-faced by ThermoSpray Process give 20 times longer service



New Metco Process hard-faced acid sludge pump rods serve as much as 20 times longer than unfaced rods.

A number of oil companies are making important savings in equipment down-time and replacement part costs with the METCO THERMOSPRAY® Hard-Facing Process. Typical of these parts are pump sleeves, as well as the acid sludge pump piston and rods shown here. Operating conditions were severe—rods had to be replaced every 24 hours—new packing every 8 hours. Hard-faced rods now last over 500 hours; packing more than 60 hours. Coatings are extremely dense and non-porous—homogeneous.

The THERMOSPRAY Hard-Facing Process consists of spraying specially developed alloys in powder form with the METCO THERMOSPRAY GUN. No compressed air is required. Coatings have hardness of Rc 30 to Rc 65, depending on the specific THERMOSPRAY alloy used; will outwear hardened steels from 3 to 10 times. Spraying speeds are higher—8 to 10 lbs. per hour—and deposit efficiency far greater (up to 97%)—than with any other type of available equipment. Hard surface depth can be closely controlled and the smooth surface left after spraying requires a minimum of finishing.

Write today for free descriptive Bulletin 126A or a call by a full-time, company-trained, Metco Field Engineer in your territory. Or see your local metallizing job shop.

The following trade names are the property of Metallizing Engineering Co., Inc.: METCO®, ThermoSpray.
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CANADA • BOLIVIA • COLOMBIA • VENEZUELA • TURKEY
OIL • GAS • WATER • PRODUCTS PIPELINES • PUMPING STATIONS

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May be used for . . .

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- RADIOGRAPHY
- LEVEL GAGING
- DENSITY GAGING
- CATALYST ATTRITION
- MIXING EFFICIENCY
- REACTION CATALYST
- PRODUCT RESEARCH
- FLOW TRACING and MEASUREMENT

Our facilities and personnel are at your disposal for assistance on these and other radioisotope uses in the petroleum industry.

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A Subsidiary of Nuclear Corporation of America, Inc.
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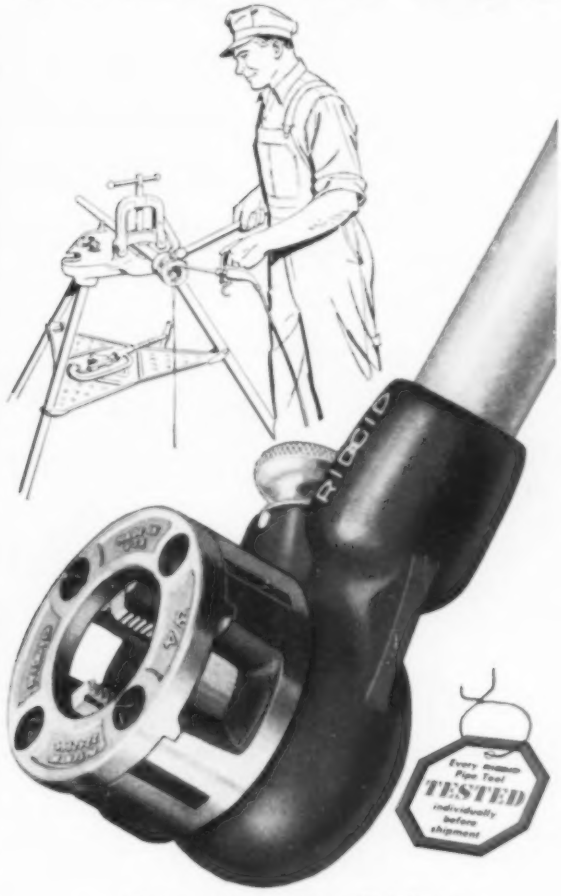
...No Equal for Quick Pipe Threading



...these handy efficient

RIDGID
Drop-Head Dies

A die head for each size, ⅛" to 2"—they snap into ratchet ring from either side, can't fall out—reverse for close threads. Tough malleable and steel heads, famous RIDGID long-wear dies—conduit or special dies available. OOR and OR, ⅛" to 1"; 111R and 11R, ⅛" to 1¼"; 12R, ⅛" to 2". Bargains in fast easy threading—at your Supply House.

The Ridge Tool Company • Elyria, Ohio, U. S. A.

RIDGID
Work-Saver Pipe Tools

Control your "X" factors CONTAMINATION and CORROSION with Glidden protective lining and coating systems!

You are at the mercy of unknowns, equipment corrosion and material contamination, which affect your profitable operation. Fortunately, losses from these factors can now be minimized, sometimes eliminated, with the application of the *proper* Glidden protective lining system.

For example, a section of a 2″ steel pipeline, carrying highly corrosive production crude, once had to be replaced every 6 to 8 months. That same section of pipe lined with Glidden *VINYL-COTE**, is undamaged after 5 years. Savings to date on this section alone: over $4300.

Your corrosion and contamination problems in vessels, storage tanks, tank cars and other equipment, can be solved in a similar way with a Glidden-engineered protective lining or maintenance coating. Write for complete information and technical product data.

*A Glidden Trade-Mark

Write today (company letterhead, please) for your copy of this new VINYL-COTE book which contains complete product information.

QUALITY Glidden PRODUCTS

THE GLIDDEN COMPANY

INDUSTRIAL MAINTENANCE HEADQUARTERS

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SALES OFFICES AND FACTORIES: San Francisco, Los Angeles, Chicago (Nubian Division—1855 North Leclaire Ave.), Minneapolis, St. Louis, New Orleans, Cleveland, Atlanta, Reading. In Canada: Toronto and Montreal.

Trade Parade

Oilfield equipment division of Black, Sivalls & Bryson, Inc. has promoted **Joe Beggs** to manager of a newly-created sales

Joe Beggs

John Williams

district that includes New Mexico, Arizona, Utah and Colorado. **John Williams** is now manager of the company's Denver oilfield district. Williams succeeds **C. D. Unsell,** who will act as special representative in the Denver vicinity.

The directors of Graver Tank & Mfg. Co., Inc. have elected **E. N. Gosselin** chairman of the board and **J. E. Swanson** president.

E. N. Gosselin

J. E. Swanson

Reginald L. Robinson has been named vice president and technical director of Jet Research Center, Inc.

Position as assistant to the advertising manager of Reed Roller Bit Company has been accepted by **Daniel H. Reat** of Houston, Texas.

Fred J. Myers is now general manager of Hammond Iron Works' western division, with headquarters at the Provo, Utah, offices.

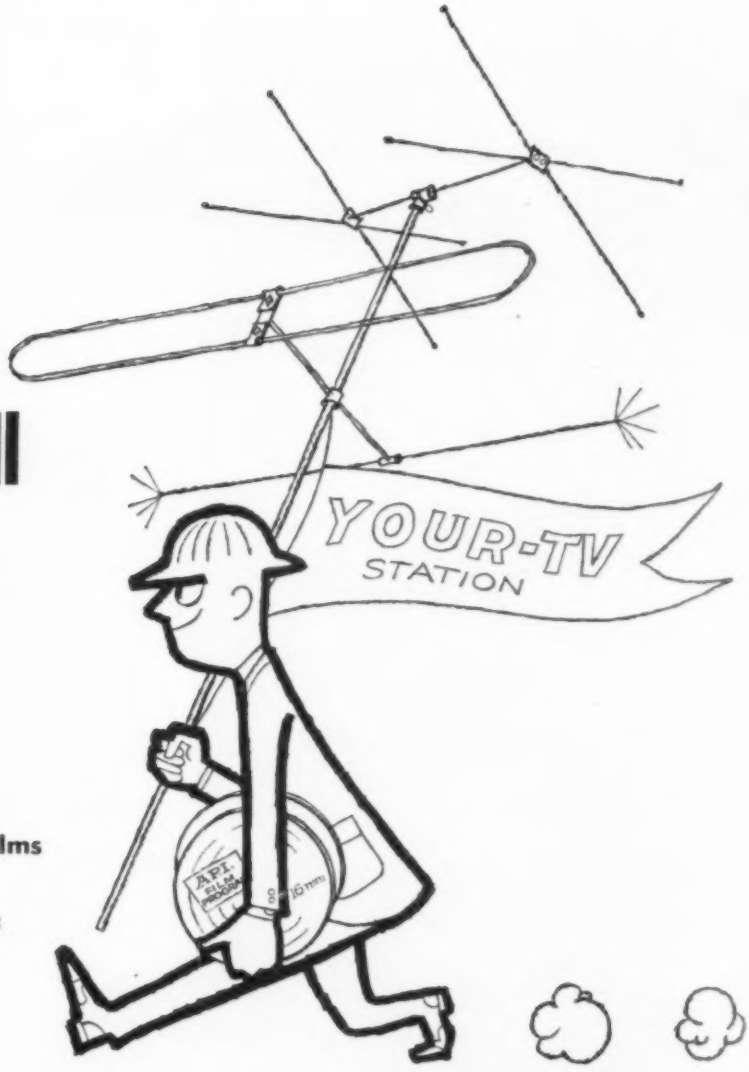
F. J. Myers

W. S. Carpenter III

W. Samuel Carpenter III has been appointed director of sales of Du Pont's petroleum chemicals division. He succeeds **David H. Conklin,** who becomes managing director of the Du Pont Company (United Kingdom) Ltd.

Other personnel changes in the petroleum chemicals division are: **Alfred R. Mullis** becomes assistant director of sales, **Earl G. Bennett,** eastern regional manager, and **Donald W. Frison,** central regional manager. **Charles D. Towery,** manager of the Gulf Coast region, will take over the management of the Mid-Continent region in addition to his present position. **R. Carter W. Jones** has been named sales service manager. **Harold C. Thompson** will become sales promotion manager.

Now you can help tell oil's story on TV!



Bring "PROGRESS PARADE" films to *your* local TV station— build prestige for yourself and your industry!

The Oil Information Committee is producing a series of special TV programs about the oil industry called "PROGRESS PARADE." Each program takes the viewer "behind the scenes" to show him this vital industry is working in his best interests. All phases of the industry are covered—and because the programs are informational in nature, stations are glad to telecast them in the public interest—without commercials.

"PROGRESS PARADE" offers you an excellent opportunity to participate in your industry's public relations program and to tell your neighbors how petroleum helps make their everyday lives more enjoyable, more worthwhile.

The Program Manager of your local TV station is constantly looking for new program features and will be happy to receive these specially prepared 13½-minute films. Four different TV films are issued every year.

How to get "PROGRESS PARADE" television films

First check if the TV station in your community has the latest "PROGRESS PARADE" film. If not, just get in touch with your local Oil Information Committee. They will provide you with the most current "PROGRESS PARADE"—and any additional information you'll need.

Don't miss this opportunity to tell *your* story—the oil story—on television. You'll be helping yourself, your company and your industry all at the same time!

American Petroleum Institute
50 W. 50th St., New York 20, N. Y.

I would like to have the "PROGRESS PARADE" films televised in my community. Please send me the address of my nearest Oil Information Committee District Office.

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ADDRESS _____

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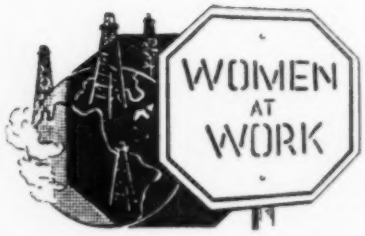
FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

... but neither summer sun nor winter snow stops Transco's search for new and profitable markets for natural gas. During 1956, Transco delivered record quantities of gas to heat-hungry markets. This year, look to Transco for a real heat wave ... a wave to increase natural gas movement—to bring heat for warmth and fuel for power to our best potential markets ... the places where the most people are.

HELPING TO EXPAND THE MARKETS FOR TEXAS-LOUISIANA NATURAL GAS

TRANSCONTINENTAL GAS PIPE LINE CORPORATION



Climbed Derricks

"First Schlumberger secretary hired in California" is an honor held by **Katherine Barnes,** now executive secretary, Pacific Coast area, Schlumberger Well Surveying Corporation. Since the age of five, when her family moved to Bakersfield, Kay has been closely associated with the Southern California oil industry. Many are the times, she recalls, when as a child she climbed derricks, slid down abandoned sump holes and poled rafts over the waste water "ponds."

After the discovery of Signal Hill, her family moved to Long Beach, where her stepfather joined Shell Oil Company. Kay graduated from University of California at Los Angeles with a BE in physical education. She intended to have a teaching career until "fate" in the form of Schlumberger stepped in to change her mind.

After joining as a secretary in 1934, Kay stayed on, rising to her present position which includes office management and counseling women personnel. In 1954 she became the first woman

Katherine Barnes

to complete 20 years with Schlumberger and received a service pin and gold watch at a special awards banquet.

Miss Barnes has continued living at the family home in Long Beach, commuting the 50 miles daily to her office in Los Angeles. A member of Soroptimist International of Los Angeles, she is active in Desk and Derrick and was on the committee which drew up the original articles of association for the formation of Desk and Derrick Clubs of North America.

WHY NOT LET BrakeSolve YOUR PARAFFIN Problem?

BRAKESOL is the safe, economical way to clean up and control paraffin in your production system. By using BRAKESOL, you get more production, by reason of having unrestricted flow and by avoiding those tank bottoms.

BRAKESOL is being used all over the world today and is accepted as one of the most effective methods of treating and controlling the paraffin problem.

BRAKESOL is safe to use and will not harm the skin, and the danger of fire hazard has been greatly minimized.

BRAKESOL is non-corrosive and will not harm production or refinery equipment.

HOLDS PARAFFIN IN SUSPENSION from FORMATION to REFINERY

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Houston, Texas	HOmestead 5-6648
Lovington, New Mexico	6-5954
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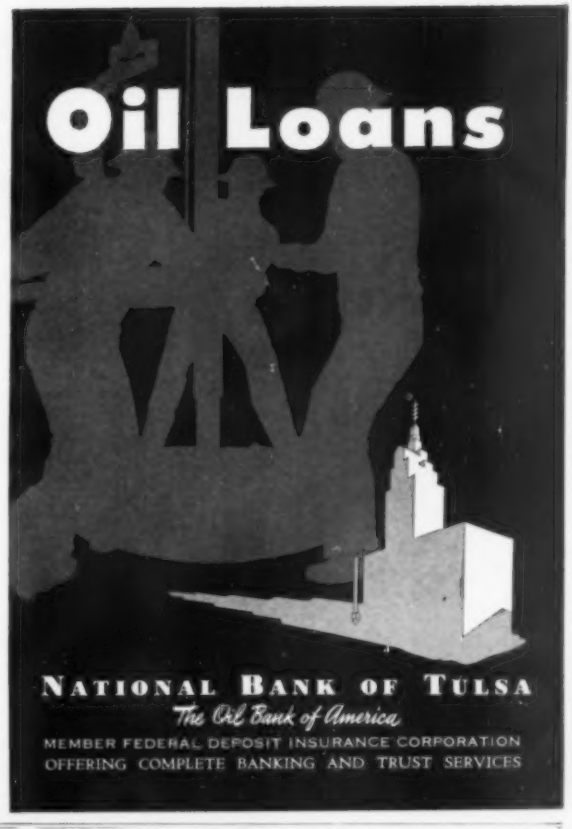
GOOD SERVICE NEAR YOU

There's a BRAKESOL Treating Engineer near you who can show you the most effective methods of application to solve your paraffin problem . . . in one easy operation. Contact him TODAY, he'll be glad to help you. For additional information, write us direct, or contact your local supply store.

BrakeSol INC.

P.O. Box 9506 Oklahoma City, Okla.

Export Distributor The National Supply Co. Export Division



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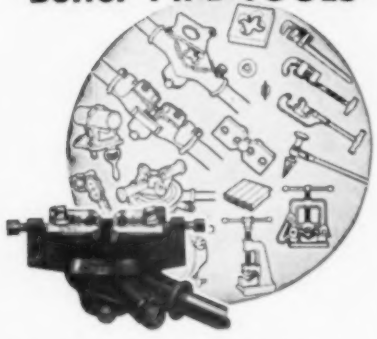
The Oil Bank of America

MEMBER FEDERAL DEPOSIT INSURANCE CORPORATION

OFFERING COMPLETE BANKING AND TRUST SERVICES

ARMSTRONG BROS.

Better PIPE TOOLS



Reversible Ratchet STOCKS and Adjustable DIES

Exceptionally convenient where space is limited, this stock simplifies pipe threading close to walls, in corners and wherever operating room is restricted. With *adjustable* dies (cut exact, over or under size threads) it is an ideal tool where valves and fittings are being installed or maintained.

"ARMSTRONG BROS." Adjustable Dies are of Special Vanadium Tool Steel, have "backed-off" teeth, correct cutting angle, ample chip clearance and correct throat angle. They start and cut easily, hold their sharpness and "spin" off pipe without jamming or tearing threads.

Write for Catalog

ARMSTRONG BROS. TOOL CO.

"The Tool Holder People"

5231 W. ARMSTRONG AVENUE • CHICAGO 30, ILL.

SHOP TIP

For an Easier Way to Remove Packing

Here is a rugged, flexible, hand-tool that "works around corners" for removing old packing from stuffing boxes. The picture above shows how Dura Hooks operate around obstructions. All steel — tempered steel cork-screw bit — made in 6 sizes — nominal in price.

DURA HOOKS

Ask your jobber—or write for DURA HOOK Bulletin No. PEDH covering sizes and prices.

The PERFECT SEAL

DURAMETALLIC CORPORATION

KALAMAZOO MICHIGAN

CATERPILLAR

Pushing through the world's longest pipeline

With 35 Caterpillar-built units in its spread, Majestic Contractors, Ltd., is laying 34-inch at a pace usually reserved for smaller pipe

Seven Cat No. 583 Pipelayers are helping Majestic Contractors, Ltd., lay 1½ miles of 34-inch pipe a day on the Trans-Canada pipeline.

No. 12 Motor Grader and two D7s are used on backfilling operations. The spread includes 35 pieces of Caterpillar equipment—engines, pipelayers, tractors and motor graders.

A Cat D339 Diesel powers this Cleveland ditcher in Saskatchewan. There are nine rugged, heavy-duty Caterpillar Engines at work in the spread.

When finished, the Trans-Canada pipeline will be the longest in the world. It will slash 2,500 miles across Canada, bringing Alberta gas as far east as Montreal.

Majestic Contractors, Ltd., of Edmonton, Alberta, is laying a 100-mile section of the pipe from Burstall to Leinan, Saskatchewan. It is putting the 34-inch pipe into the ground at an average rate of 8,700 feet per day. This equals the rate that smaller big-inch pipe is being laid elsewhere in the industry. In one record 10-hour working day, Majestic welded 305 joints of 40-foot-length pipe.

Spread No. 1, which is setting this pace, is practically all Caterpillar. It includes seven new CAT* No. 583 Pipelayers, the highest capacity machines in the industry; five MD7 Pipelayers; seven D7s; three D6s; two D4s; one D2, and a No. 12 Motor Grader. And Majestic is relying on nine rugged, heavy-duty Caterpillar Engines to power other equipment. There are seven D318s, one on a Cleveland backfiller and six on Bucyrus Erie shovels. In addition, there are two D339 Diesels on Cleveland ditchers.

Right-of-way is 65 feet. The ditch measures 52 inches at the bottom and 90 inches at the top. This is widened to 8 feet, 4 inches in sandy terrain. Here the No. 583 Pipelayers stay 10 to 12 feet from the 6-foot-deep ditch to lower the 150-pound-per-foot, 34-inch pipe. All pipe is being cradled in immediately following the doping and wrapping operations.

You can look for the production record on this job to become increasingly common in the industry as new No. 583s join more and more spreads. This is the highest capacity pipelayer in history, and it is establishing a new standard for a day's work. This efficient pipelayer can lift 130,000 lb. and its engine delivers 191 HP. And because of its well-balanced design, it is as safe as it is fast.

In the complete line of Caterpillar* oilfield machines and engines, there is a unit to fit every need. So call your Caterpillar Dealer soon. He will demonstrate any of his high-production machines on your job—at your convenience.

CATERPILLAR TRACTOR CO., PEORIA, ILLINOIS, U. S. A.

*Caterpillar and Cat are Registered Trademarks of Caterpillar Tractor Co.

Roebling Royal Blue Wire Rope will **wear** and **wear** and **wear**!

This working quality means longer service life on *your* job. Add to this the fact that Royal Blue is stronger than the strongest rope you have been using and you have two excellent reasons why it has enjoyed faster acceptance than any wire rope in Roebling's history. Your distributor or Roebling Sales Office will give you the complete story, or contact John A. Roebling's Sons Corporation, Trenton 2, New Jersey.

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Distributors, Branches and Warehouses Throughout the Country—Subsidiary of The Colorado Fuel and Iron Corporation

stop this

in salt water disposal well tubing

use Fibercast WELL TUBING

This is Fibercast, *an untouched photograph of Fibercast Well Tubing after 2½ years in disposal use. No deterioration! No loss of strength!*

More than 5 years proven successful operation in down-hole tubing, and still going where other materials fail in a matter of a few months. All this adds up to real protection of the Casing & Well investment.

Fibercast is non-corrosive — plus:

1. Tensile & Joint Strength — For settings to 7,000′ depths.
2. Collapse Strengths — Allows filling the annulus with protective fluids.
3. Acidizing — Is safe directly through the Fibercast Tubing.
4. May be Engineered with or without Packer.
5. Fast Thread System and Light Weight makes for low installation cost.

THE FIBERCAST CORPORATION
A Subsidiary of The Youngstown Sheet and Tube Company
Sand Springs (Tulsa), Oklahoma

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LIGHT-WEIGHT PIPE

With the GUTS to Gather Gas

Just because Naylor Spiralweld pipe is light in weight, you don't have to baby it in gas-gathering service.

The same structure that gives Naylor its distinctive appearance makes it stronger and safer. The spiral lock acts as a continuous expansion joint to absorb shock loads, stresses and strains and gives the pipe greater collapse strength.

It's this combination of performance features that gives Naylor pipe the guts to handle any gathering assignment throughout the entire range of diameters from 4 to 30 inches.

Naylor Spiralweld is available with standard weight pipe ends for stronger field welds.

Write for Bulletin No. 507 or call our distributors.

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STOP —off lines...

but maintain flow!

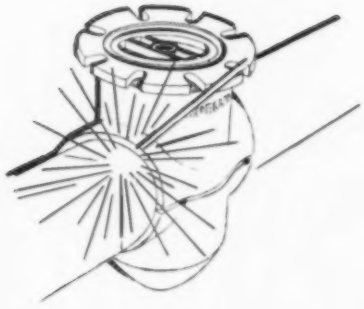
The **MUELLER** *No. 3 Line Stopper Unit*

When repair, replacement or a tie-in is necessary on a 6" or 8" line, a Mueller No. 3 Line Stopper Unit can shut-off the line under pressure, yet service need not be interrupted.

Line Stopper Fittings and Drilling Nipples are welded to the pipe and gate valves attached. The pipe is cut by a C1-36 or CC-36 Drilling Machine and a by-pass line installed. The Line Stopping Machine inserts and expands a stopper which safely isolates the section of pipe to be worked on. When work is completed, the by-pass is removed, fittings capped, and normal operations are resumed.

Flow is maintained without a minute's interruption. The line is under pressure through every step of work, but there is *no* escape of fluid, *no* reduction of safety!

Stop off those lines that need attention, but keep flow on the go – get the details on Mueller NO-BLO® Line Stopping Equipment from your Mueller Representative or write direct.



NO-BLO

Unit No. 3, for 6" and 8" lines, consists of two H-17335 Stopping Machines, one H-17345 Completion Machine and one set of attachments. Max. pressure: 60 p.s.i.; max. temperature: 250°F.

Unit No. 3SW, for 6" and 8" lines, with two H-17340 Stopping Machines, one H-17346 Completion Machine and one set of attachments is used for higher pressures. Max. pressure: 230 p.s.i. at 100°F.; max. temperature: 250°F. at 200 p.s.i.

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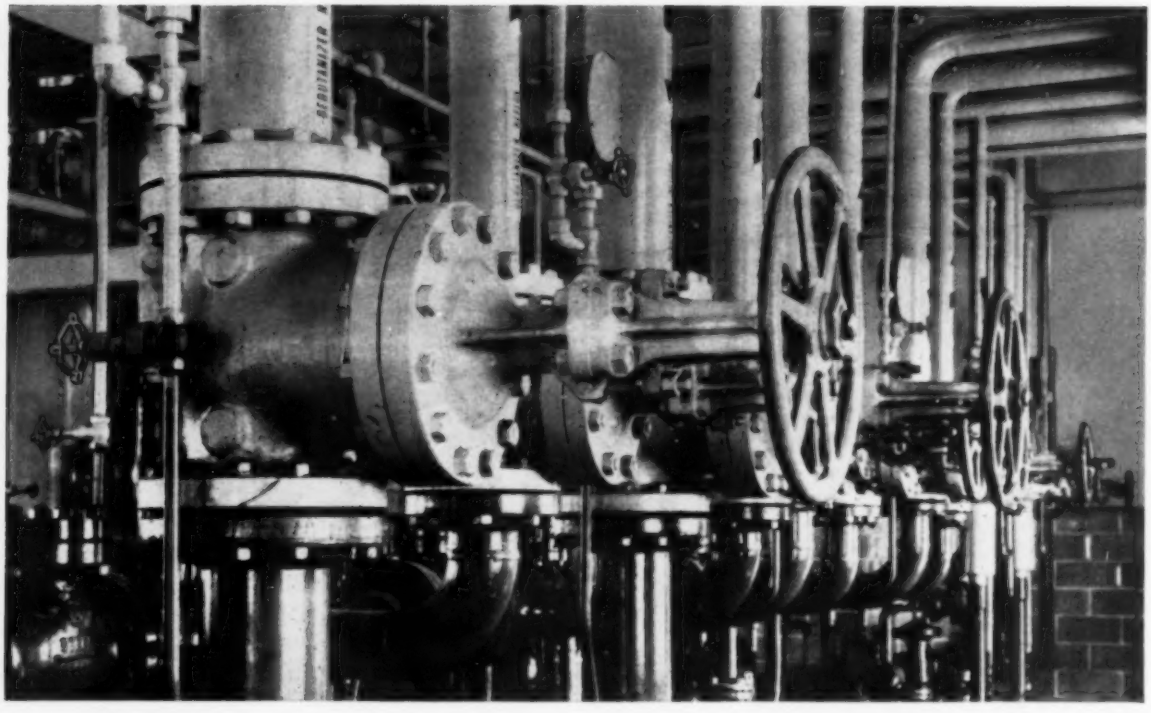
Since 1857

Don't Hedge on Quality When You Buy Steel Valves...

Maintenance costs can gobble up your savings in a few months!



LUNKENHEIMER QUALITY is no longer a luxury—it's your vitally needed insurance against today's sky-high maintenance expense. Labor rates are going still higher . . . "downtime" costs are multiplying . . . repair charges are rocketing up—with no relief in sight. Today, it pays to buy the *best valves you can get,* with no hedging on quality. Your purchase of Lunkenheimer Steel Valves is an investment that pays worthwhile dividends in maintenance savings . . . year after trouble-free year. The Lunkenheimer Company, Box 360, Annex Station, Cincinnati 14, Ohio.

The cost of a LUNKENHEIMER VALVE
Gets smaller...and smaller...and smaller...
with each passing year af dependable service

A check on the cost of maintaining your cast steel valves will prove this point.

STEEL • BRONZE • IRON • PVC

L-1056-2

LUNKENHEIMER QUALITY

LUNKENHEIMER®
THE ONE *Great* NAME IN VALVES

exhaustive tests prove:

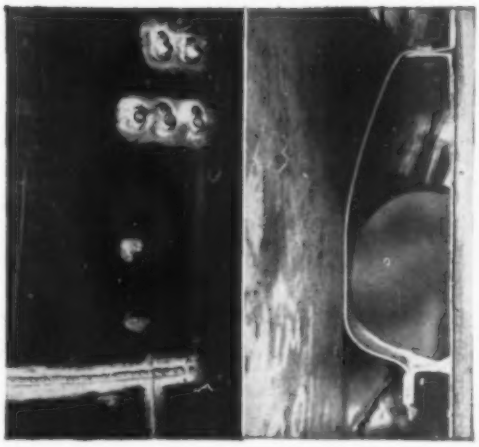
36 YEARS FROM TODAY

TUBESEALS* NOW IN FLOATING ROOF TANKS WILL OPERATE AS EFFICIENTLY AS THEY DO TODAY!

WE DOUBT this can be claimed for any other floating roof seal!

To determine the efficient life-expectancy of the Hammond Tubeseal in service, tests were made under the worst possible conditions to which a floating roof seal can be subjected. The Tubeseal was moved across very rough rivet heads, erection burrs and abrasive weld surfaces, for a total travel of 70,000 feet. This is equivalent to a normal wear of *more than 36 years in actual service.* Moreover, as the tests were run dry, there was the added disadvantage of the absence of lubricating effect normally created by wetted surfaces. Upon completion of these rigorous tests, the scuff band had only worn through the ribs and had barely penetrated through the material, leaving two-thirds of the stock intact; proof that the Tubeseal is unimpaired after traveling 70,000 feet.

The 36 year life-expectancy of a Hammond Tubeseal assumes no mechanical accident and is arrived at in the following manner: Each year a floating roof, in normal service, makes about 48 trips to and from top and bottom of tank. The roof of a 40 foot tank, therefore, will travel 1920 feet per year. Assuming 1920 feet of travel per year (based upon full depth of travel) and applying our accelerated wear test, the Tubeseal will be serviceable for at least 36 years 5½ months.



THE TUBESEAL TEST:

total travel	70,000 feet
travel over vertical weld	46,400 feet (on same line)
Horizontal welded seam crossed	21,200 times
Flat head rivets crossed	63,600 times

CONDITION OF TUBESEAL AFTER TEST: Scuff band had worn through ribs and had barely penetrated into the main material, leaving ⅔ of stock intact.

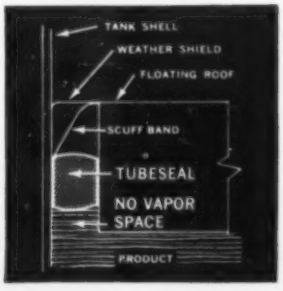
Tests were conducted dry with no aid of lubricant normally resulting from stored product.

Photos show projections used for test. Included are 16"of ⅜" horizontal weld—24" of sharp, irregular vertical weld—2 erection burrs—3 ¾" flat head rivets and 2 ¾" cone head rivets.

THE HAMMOND TUBESEAL
is the most efficient and positive seal known.

it features:

no moving parts
no mechanical maintenance
climate proof
non-corrodible
can operate to bottom of tank or above the top
no vapor space below the seal
entire circumference has tight seal under pressure at all times
longer working life expectancy



NO ROOM FOR VAPORS
NO EVAPORATION
NO CORROSION

patented* ***Write for bulletin TS*

HAMMOND TUBESEAL — THE MOST EFFICIENT AND POSITIVE SEAL KNOWN

HAMMOND IRON WORKS

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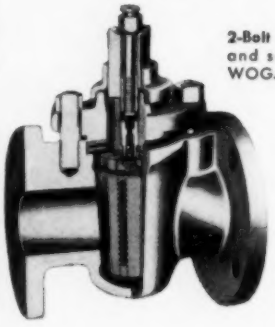
Cut flow control costs . . . standardize on . . .

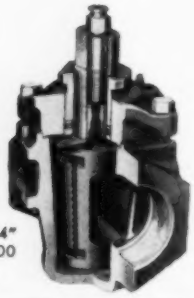
THE WORLD'S MOST COMPLETE

LUBRICANTS and

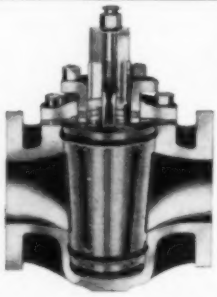
VALVES



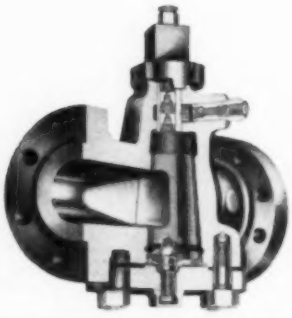
2-Bolt Cover Type Valve in 4" and smaller sizes for 175-lb WOG. *Semi-Steel*



Screwed Gland Type Valve in 4" and smaller sizes for 200, 400 and 500-lb WOG. *Semi-Steel*



Bolted Gland Type Valve in 4" to 36" for 200 through 800-lb WOG Semi-Steel and ASA 150-lb and 300-lb Carbon Steel.

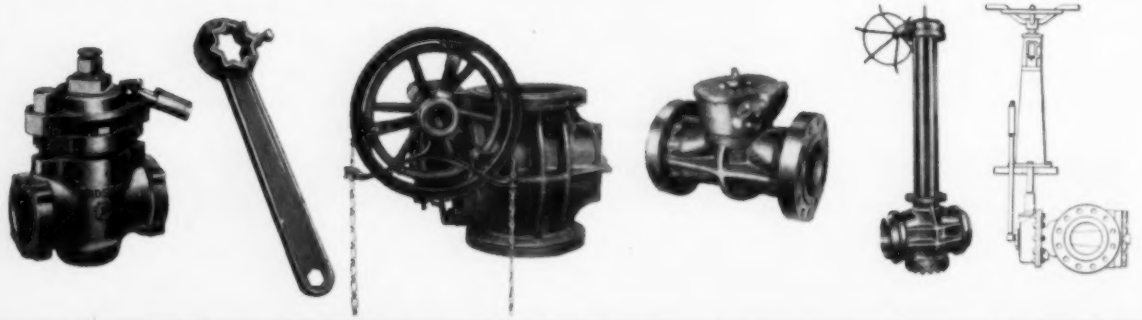


Hypreseal Valve—Bolted Bottom Cover Type. ½" to 30 by 34" for ASA 150-lb through 1500-lb Carbon Steel (with rectangular opening). API 2000-lb and 3000-lb WOG Alloy Steel Rectangular Opening. API 2000 and 3000-lb WOG Alloy Steel (with round opening).

LUBRICANTS

PROPER VALVE LUBRICATION means longer valve life and better performance at lower cost. Rockwell is the world's oldest and most experienced manufacturer of lubricated plug valve lubricants. To assure perfect performance, a *complete line* of lubricants has been developed and field proved. For convenience, they are available in stick, tube and bulk forms. The Rockwell High Pressure Booster Type Hand Gun and Rockwell High Pressure Booster Type Bucket Gun make the lubrication of even a great number of valves a job that takes only minutes.

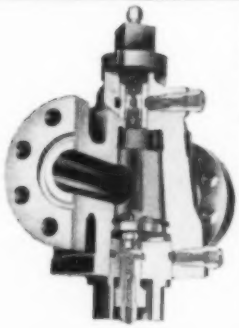
ACCESSORIES



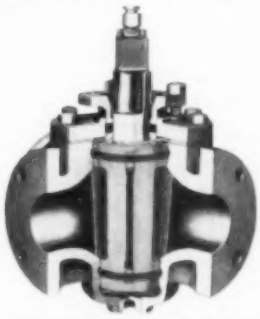
GREATER DESIGN AND INSTALLATION FREEDOM are the "extras" you get when you specify Rockwell-Nordstrom valves and accessories. No matter what your operating requirements or problems, you can select from a *complete* line of valve accessories that assure easier, safer, more efficient operation. While only a few of the valve accessories are shown above, you can learn about the complete selection by talking with your Rockwell-Nordstrom sales engineer or writing directly to: Rockwell Manufacturing Company, 400 N. Lexington Avenue, Pittsburgh 8, Pennsylvania.

LINE OF LUBRICATED PLUG VALVES,

ACCESSORIES



Hypreseal Valve—Screwed Bottom Cover Type. ½" to 8" for 7500-lb WOG Alloy Steel (rectangular opening). ASA 2500-lb Carbon Steel (rectangular opening). API 5000-lb and 10,000-lb WOG (rectangular opening) and API 5000-lb and 10,000-lb WOG (round opening).



Multiport Valve Type. Available in Gland type and Hypreseal type in WOG pressures to 400 lb and ASA pressures to 1500-lb. Sizes from ½" to 24".

ALL THESE ADVANTAGES

In *Every* Rockwell-Nordstrom Valve.

LEAKPROOF: Lubricant sealing is a *double* seal against leakage.

LONG-LIFE: Lubricant prevents metal-to-metal wearing friction.

LOW-COST: Lubrication is preventive maintenance.

DEPENDABLE: Hydraulic lubricant action jacks plug for instant operation.

QUARTER-TURN OPERATION: 90° turn for *full* positive shut-off.

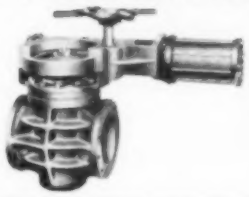
SMOOTH PASSAGE: Straight-through flow without crevices . . . minimum pressure drop.

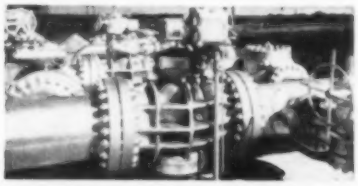
UNEXPOSED SEATS: Corrosion and erosion eliminated in vital seat areas.

ADJUST, LUBRICATE UNDER PRESSURE: Never down time for routine servicing.

No other valve—at any price—can offer the performance and longer life at lower cost of Rockwell-Nordstrom valves.

POWER OPERATORS

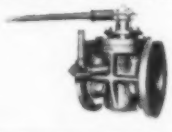




AUTOMATIC VALVE OPERATION is more dependable and economical when you specify Rockwell-Nordstrom valves. They are far superior to ordinary valves for power operation because *lubrication* reduces operating torque—smaller, less costly actuators can be used. And since there are no forced, wedged seats to be set, the actuator has only to move the lubricated plug through 90°.

Typical electric, pneumatic and cylinder operators shown above represent only three of the more than fourteen power operation arrangements available.

VALVES WITH SPECIAL FEATURES



NO MATTER WHAT YOUR NEEDS, there is a Rockwell-Nordstrom valve that will do the job better, longer and at lower cost. A few of the Rockwell-Nordstrom valves with special features are shown above.

Special metal valves are available in stainless-steel, bronze and other corrosion resisting alloys for even the toughest services. Valves with *hard faced plugs and bodies* combine the economy of semi-steel with hard facing for utmost corrosion and wear resistance. *Steam jacketed valves* for precise product temperature control. *By-pass relief valves* prevent pressure build-up that imposes dangerous stress on ordinary valves and fittings. *Gas safety control (Factory Mutual) valves* for positive control against explosion in multi-burner gas-fired furnaces, ovens and driers.

* * * *

Rockwell-Nordstrom valves and accessories are available at leading oil field and industrial distributors everywhere. For full information write: Rockwell Manufacturing Company, 400 N. Lexington Avenue, Pittsburgh 8, Pa. Canadian Valve Licensee: Peacock Brothers Limited.

ROCKWELL-Nordstrom **VALVES**

Lubricant Sealed For Positive Shut-off

Now...a New advance in...

Gauge Safety!

Another step ahead in Marsh Gauges: the new Marsh "Safecase". Down to the final detail this gauge is developed for those applications where an unexpected surge of heavy, explosive over-pressure can occur.

In the "Safecase" a solid metal barrier protects the entire face. But, still more important, the *entire back* of the gauge is a thin, ductile plate, designed to open out when subjected to abnormal pressure. Back plate is held firmly to the case by two holding screws and cannot be dislodged by a pressure blowout.

In exhaustive tests it has never been possible to shatter the crystal or create any other dangerous condition in a "Safecase" gauge with its safety-release back. The accompanying illustration shows the result of one of a series of tests in which blank cartridges were fired in the back of the case without even breaking the crystal. Think what that means in safety to operating men!

Yes, an important development . . . but merely the kind you would expect from the manufacturer who originated the "Connoweld" tube, the "Marshalloy" case, the Mastergauge movement and practically all of the major advancements in pressure gauges. Ask for up-to-the-minute information.

Pressure of explosive force merely opens out safety back

Instead of depending on blow-out plugs, entire back of Safecase Gauge is designed to yield to over-pressure. Photo at left shows actual result of firing cartridge within back of case. Safety-release back exhausted pressure. Front remained intact.

MARSH INSTRUMENT CO.
Sales affiliate of Jas! P. Marsh Corp.
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HOUSTON BRANCH PLANT:
1121 Rothwell St., Sect. 15, Houston, Texas
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"THE STANDARD OF ACCURACY"

MARSH GAUGES

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

Used by more drillers on more mud pumps than any other V-belt made

World leadership is the result of these 4 engineering developments

1. Tougher, more resilient cords are able to absorb the severe pulsations of mud pumps; easily handle peak loads.

2. True-fitting concave sidewalls (U. S. Pat. No. 1813698). As a Gates Belt bends around a sheave, the concave sides fill out . . . become straight . . . fit sheave grooves evenly. (Fig A.) This uniform groove contact insures greater pulling power, less wear, longer life.

Straight sided belts bulge at the sides when bent. Uneven contact (Fig. B) causes uneven wear; shortens belt life.

3. Stabilizing ribbed tops (U. S. Pat. No. 2548135) are exclusive with Gates. They dampen vibration, protect top of belt from damage, keep belt running smoothly over idler-equipped mud pump drives with no side whip.

4. Flex-Weave cover (U. S. Pat. No. 2519590) provides greater flexibility with far less stress on fabric. Wears longer . . . lengthens belt life . . . lowers belt costs.

The four engineering developments shown at left make Rib-Top an outstanding performer in mud pumping operations.

Yet Rib-Tops cost no more than ordinary belts of comparable ratings.

For fewer V-belt replacements and lower costs on mud pump drives, always specify Rib-Top. Both Standard and Super Rib-Top are available at your nearby oil field supply house.

The Gates Rubber Co., Denver, Colorado

World's Largest Maker of V-Belts

Put Super Rib-Top on the tougher drive jobs. With 40% greater horsepower capacity, Super Rib-Top easily handles drive overloads. Fewer belts and narrower sheaves solve space and weight problems.

Gates The Mark of *Specialized* Research

Gates Rib-Top Vulco Rope

DEVELOPED ESPECIALLY FOR MUD PUMP DRIVES

TPA 167

The world's population is growing steadily and each new person requires the use of energy to feed, clothe, and house him. . . . There is a widespread growth in the desire of people to live better, to get more out of life. All of this calls for more energy.

M. J. Rathbone, President, Standard Oil Company (New Jersey)

Esso 75 YEARS

producing energy for an abundant life

STANDARD OIL COMPANY (NEW JERSEY)
AND AFFILIATED COMPANIES

Three Rust-Oleum DIFFERENCES that save you time, money and metal!

GOES ON FASTER

No tedious surface preparations usually required — just scrape and wirebrush to remove rust scale and loose rust — then brush Rust-Oleum 769 Damp-Proof Red Primer right over the remaining rust.

STOPS RUST

Rust-Oleum's *specially-processed* fish oil vehicle works down through the rust into the tiny, microscopic pits in the bare metal where it drives out air and moisture to *stop rust.*

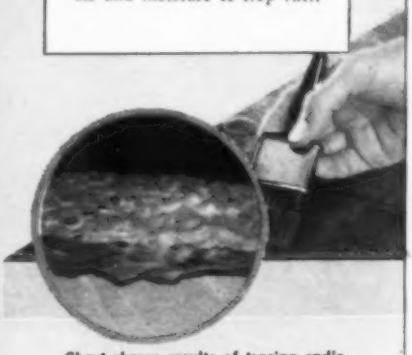
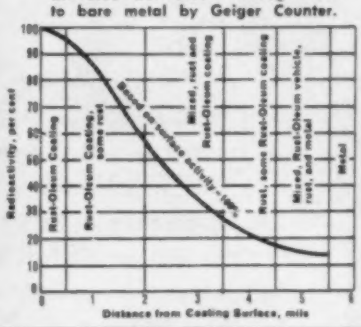


Chart shows results of tracing radio-activated Rust-Oleum through rust to bare metal by Geiger Counter.



LASTS LONGER

Applied over rust, Rust-Oleum lasts longer for the *over-the-years protection* you need. It resists sun, salt water, salt air, fumes, heat, humidity, moisture, weathering.

These are just a few of many important *differences* that separate Rust-Oleum from ordinary coatings. When you consider that Rust-Oleum covers approximately *30% more area,* depending upon surface condition and porosity . . . and the fact that Rust-Oleum finish coatings, with the same fish oil vehicle, are available in nearly every color for *double protection* . . . it's just good, common sense to use Rust-Oleum. Prompt delivery from Industrial Distributor stocks. Write for illustrated literature with color charts.

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- ☐ 30-page report on Rust-Oleum penetration.
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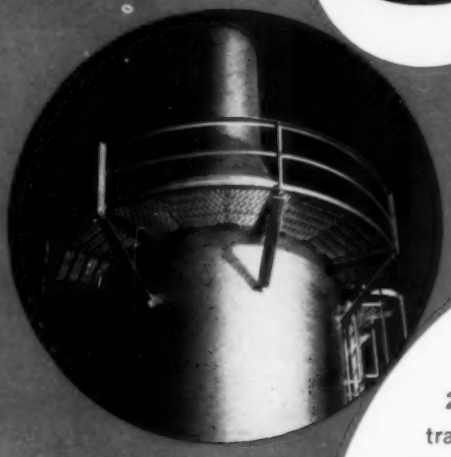
you can judge

the comparative values of furnace design as applied to operating requirements.

It's quite simple

there are **9** basic factors which must be evaluated to obtain the full comparison of values



1—Average radiant transfer rate. **2**—Maximum deviation from average radiant transfer rate. **3**—Average and maximum transfer rate in convection section. **4**—Maximum tube wall temperature, radiant or convection. **5**—Maximum efficiency with specified excess air. **6**—Controlled thermal recirculation of flue gases to provide even heat distribution throughout full length of each tube and equalized heat distribution around each tube. **7**—Overload and corresponding transfer load. **8**—Design to provide: structural column supports - Ladders - Platforms - Tube Removal facilities, etc. **9**—Degree of assembly; of the furnace structure and of the heating surface.

Whenever all these 9 specifications are applied to all the operating requirements, you can be sure PETROCHEM ISOFLOW FURNACES will be found most economically desirable.

No other furnace design can claim the recognition and acceptance achieved by PETROCHEM ISOFLOW FURNACES . . . starting with one installation in 1940, January '57 records more than 1650 ISOFLOW FURNACES in operation and under construction—a record that is incomparable just as all Petrochem Isoflow furnaces are more economically desirable by any comparison.

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Write today for new Application Chart—matches spark plug recommendations to engine service —you'll get better plug performance.

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STITT MAKES HEAVY-DUTY, INDUSTRIAL-TYPE PLUGS!

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1600' on 200 acres in Tulsa, Co., completed 2 years ago — has averaged 15 B/daily under adverse conditions. *Well was not fractured* — has high gas pressure and makes no water. Engineers state fracture will multiply production in offset locations. Geologist reports every location should produce. Drilling Company owners — will drill and equip one or more of these offset locations for you — into the tanks and pipeline for $17,000.00 each — for a one-half interest in each well. Oil $2.99 P/B. Present allowable 30 B/Day. Write — Box 190, Petroleum Engineer, Dallas, Texas.

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Single & Multi Engine Commercial Pilot. Single, 3,000 flying hours. Graduate Aircraft maintenance engineer, Graduate Aircraft Test Pilot, Graduate Aircraft Radio & Radar Schools. Experience flying five continents and Atlantic and Pacific Oceans. Desire position with major oil company. **Reply William B. Perry, 4082 West Greenwood Pl., Denver, Colo.**

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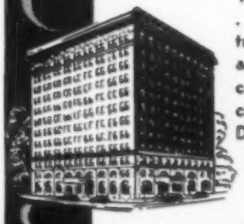
Member Diners' Club



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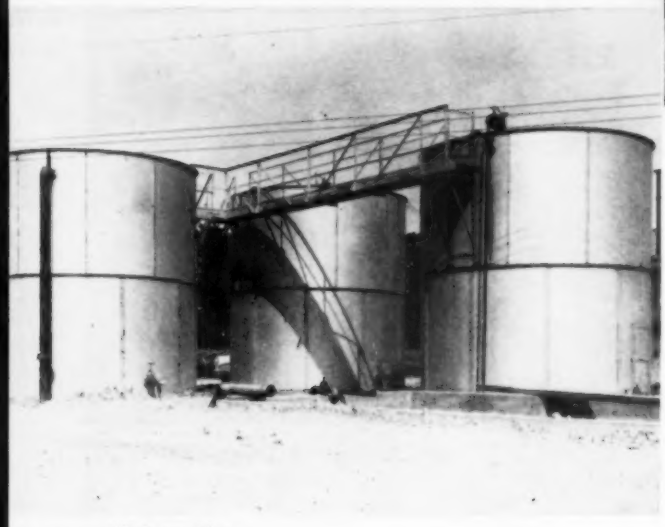
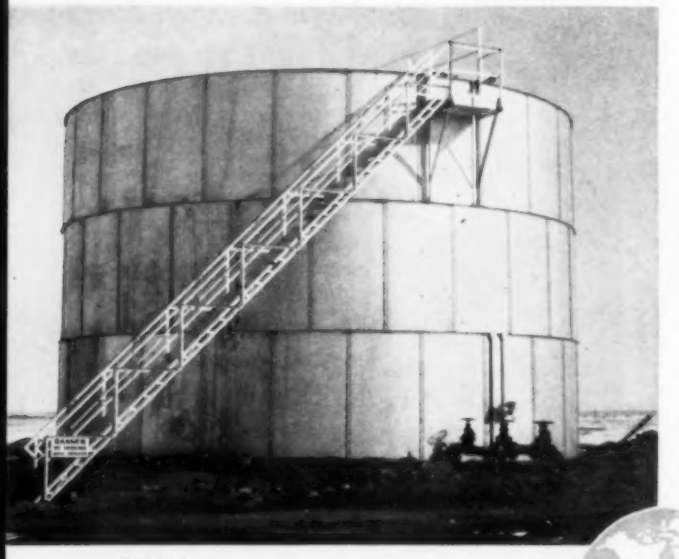
ABOUT BOLTED TANKS

Aluminum Sides and Deck, Rezo-Glas Bottom and 2′ Side Ring



All Rezo-Glas



All Steel

Bolted steel tanks can be delivered immediately* to your location in standard capacities of:

65 bbl.	300	2,000
100	500	3,000
130	750	3,333
195	1,000	5,000
200	1,500	6,666
250	All made to API Dimensions	10,000

*Delivered immediately means the time necessary to haul to location from any one of 45 correctly located Bolted Steel Tank stocks in the U.S. and Canada. National Supply Corp., our export agents, carry our tanks and parts in several foreign countries, including Venezuela.

Bolted Rezo-Glas** Plastic Tanks or Combination Plastic and Steel and/or Aluminum can be shipped in capacities up to 500 bbl. from our factory in Tulsa, Oklahoma.

Steel is available in painted finish or

HOT-DIPPED GALVANIZED AFTER FABRICATION

(National built the FIRST such tank in 1936)

After 20 years of service throughout the oil fields everywhere, thousands of these tanks are giving a good account of themselves:

- In Sour Oil Areas (corrosive oils and gases require them)
- In Humid Salt Air Areas (offshore and other locations)
- For Fresh Water Storage (at camps and for cities)

NATIONAL GALVANIZED AFTER FABRICATION STEEL TANKS require no painting for years after erection and they are PORTABLE.

TANK COMBINATIONS AVAILABLE ONLY from National include:

1. Painted Bolted Steel Tanks (flat or coned bottom)
2. All GALVANIZED Bolted Steel Tanks (flat or coned bottom)
3. ALUMINUM Deck, GALVANIZED Rings and PLASTIC Bottoms
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5. PLASTIC Bottom and Shell with ALUMINUM Deck
6. All PLASTIC Tank

Take them anywhere — erect them — remove them in parts two men can handle with ease.

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It's a National®

NATIONAL TANK COMPANY

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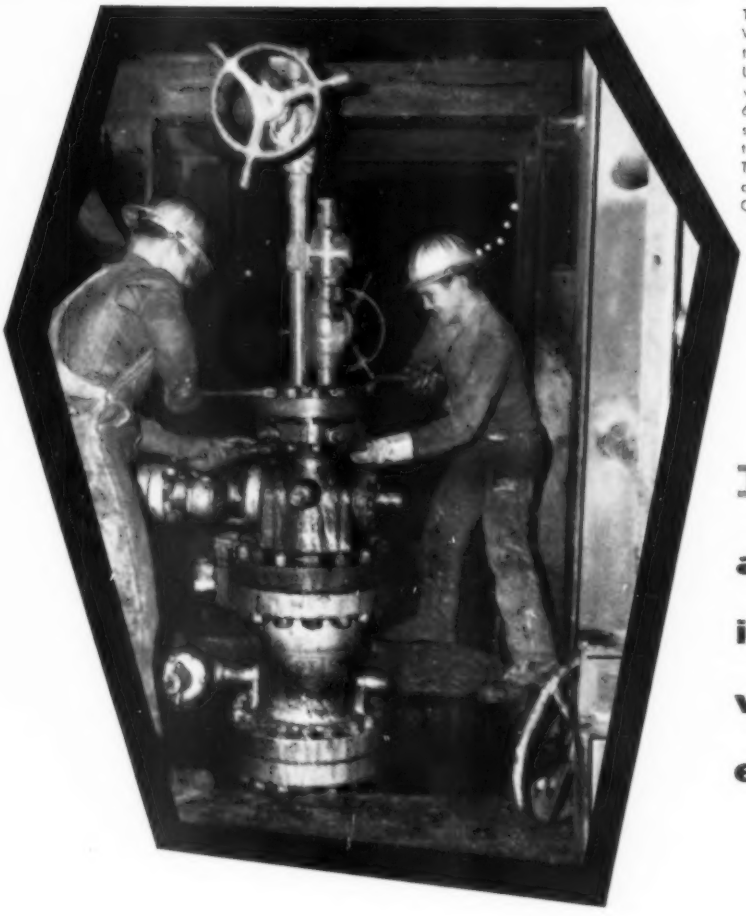

This O-C-T Dual String Wellhead Assembly has the new O-C-T Universal Tubing Head which accommodates 6 interchangeable dual string and single string tubing hangers. The foundation is an O-C-T "C-19" Casing Head.

FIRST

and still first... in high pressure wellhead equipment

This O-C-T Dual Completion Tree is only one of many economically important products pioneered by Oil Center Tool Company. It is the result of more than 15 years of continuous improvement in multiple zone completions.

Other O-C-T "Firsts:" the FIRST factory-assembled and tested Christmas Tree . . . the FIRST 10,000, the FIRST 15,000, the FIRST 30,000 pound test Christmas Trees . . . the FIRST casing head with an automatic seal . . . the FIRST and only flow control that gives advantages of both a choke and a valve . . . the FIRST universal tubing head.

When you are ready to complete your next well, turn first to the organization that was first . . . and still first . . . in meeting your present and future needs for dependable high pressure wellhead equipment. You'll be money ahead!

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You get Big Gun Effectiveness with a Small Diameter Gun

You get Lane-Wells first-in-perforating experience

Yes, Lane-Wells Swing Jet travels through 1½ or 2 inch I.D. tubing and swings open below tubing to give you Big Gun Effectiveness with deeper penetration—even under pressure.

AND since Lane-Wells has been perforating longer than anyone else in the business, you can rest assured they'll do your job right. So for your thru-tubing perforating, ask for LANE-WELLS Swing Jet. And for perforating under any conditions, you can count on Lane-Wells Complete Perforating Service. There's always a Lane-Wells gun to do your job RIGHT—and the experience to go with it. Swing Jet is ONE in the selection of Lane-Wells guns. Call your nearby Lane-Wells man about the COMPLETE Perforating Service.

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Of Things To Come . . . In Oil

NATURAL GAS BILL NEEDS BACKING, but has good chance. The Alger-Harris Natural Gas Bill, introduced by Rep. Bruce Alger of Texas, did not get the "push" from the White House, although Alger is close friend of the President who favors non-federal regulation. If distributors, transmission companies and producers get together, it should go through this time.

PETROLEUM DEMAND UP 50 PERCENT may be anticipated by 1965, says Ira Cram, Continental vice president. This would impose the greatest oil finding effort in our history, to discover perhaps as much as 55 million bbl and 180 trillion cu ft of gas in the next decade.

BEST YEAR AHEAD FOR ROCKY MOUNTAIN AREA if last year's performance is any gage. Activity rising as new and significant discoveries are made; the biggest effort yet is underway. Last year, total industry expenditures passed the $1 billion mark for the first time. The Paradox Basin in the Four Corners area looks hottest right now.

CONTINUOUS LOGGING-WHILE-DRILLING is rapidly approaching the commercial stage as Lane-Wells nears the end of its long research program to perfect this idea where the bit acts as one of the electrodes. Drillers would have immediate data on formations penetrated, and minimum corrections to electrical values would be necessary.

1000 OFFSHORE WELLS ANNUALLY BY 1965 is predicted by Henry J. Wallace, National Tube (U.S. Steel) vice president, compared to an expected 600 completions this year. By 1970, U.S. Steel's study shows that some 1300 wells would be drilled each year . . . representing about 5 percent of total domestic footage.

IMPORTS AGAIN IN SPOTLIGHT with opening of Suez. Long before the mid-April date when major obstacles were cleared for shipping, domestic producers begin to feel impact. Louisiana and Texas April allowables severely cut and imports started climb. Equitable solution may be difficult with hugh backlog of mid-east production.

MARVEL INVERSE OILER–

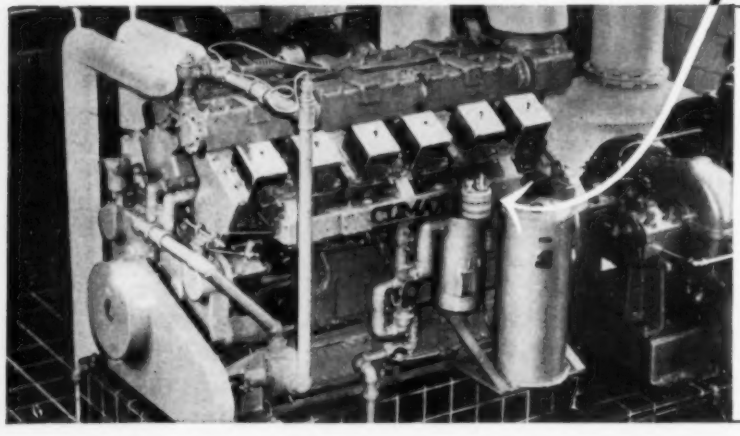
Vital Part of World's Finest Engines

Engine manufacturers think so highly of the Marvel Inverse Oiler they have incorporated it is a vital unit in their engines' lubrication systems.

They have found that engines, equipped with Marvel Inverse Oilers, can be depended upon to give quick acceleration to save trip time . . . keep operating costs to a minimum . . . guarantee hours of continuous performance . . . keep "down-time" low by extending periods between overhauls.

The famous Climax Engines, one of which is pictured below, is an example. A truly fine performer, it is equipped with a Marvel Inverse Oiler for Marvel Mystery Oil—finest performing lubricant of all.

The Marvel Inverse Oiler feeds Marvel Mystery Oil in exact proportion to engine speed and load . . . properly lubricating valves and guides, preventing wear and sticking. Keeps upper piston rings free in their grooves . . . retards ring flutter . . . and cushions ring pounding which can result in ring breakages. Remember, it is the *oil* which must do these things and only Marvel Mystery Oil is blended for this purpose and for this oiler.



The Marvel Inverse Oiler

is an integral part of the Climax 12 cylinder, 171 H.P., 600 RPM GAS ENGINE. Operating off the intake manifold, this completely automatic Oiler feeds Marvel Mystery Oil exactly in proportion to engine loads . . . gives direct protection to the all-important upper cylinder areas.

This Chart shows the proper setting for constant load engines

BRAKE H. P. AT BELT	NAT. GAS CU. FT. PER HOUR	BUTANE GALLONS PER HOUR	GASOLINE GALLONS PER HOUR	M. M. OIL DROPS PER MIN.	M. M. OIL HOURS PER QUART
10	115.	1.07	1.12	4	228
15	172.5	1.60	1.68	6	152
20	230.	2.14	2.24	8	114
25	287.5	2.67	2.80	10	91
30	345.	3.21	3.36	12	76
35	402.5	3.74	3.92	14	65
40	460.	4.28	4.48	16	57
45	517.5	4.81	5.04	18	50
50	575.	5.35	5.60	20	45
60	690.	6.42	6.72	24	38
70	805.	7.49	7.84	28	32
80	920.	8.56	8.96	32	28
90	1035.	9.63	10.08	36	25
100	1150.	10.70	11.20	40	22
120	1380.	12.84	13.44	48	19
140	1610.	14.98	15.68	56	17
160	1840.	17.12	17.92	64	14
180	2070.	19.26	20.16	72	12
200	2300.	21.40	22.40	80	11
225	2587.5	24.00	25.20	90	10
250	2875.	26.75	28.00	100	9
275	3162.5	29.42	31.10	110	8
300	3450.	32.10	33.60	120	7

Chart shows total oil consumption

EXAMPLE:—If you use 805 cu. ft. of dry gas, 7.49 gallons of butane or 7.84 gallons of gasoline, your H.P. is about 70, so adjust oiler to feed 28 drops per minute. You will then receive about 32 hours per quart of MARVEL MYSTERY OIL.

If engine load increases after setting for normal load, oiler will automatically increase its feed, decreasing when load is lessened.

To determine drop count per oiler when more than one is used on an engine—divide recommended drop count by number of oilers.

NOTE: Guarantee on oiler is void if any other oil than MARVEL MYSTERY OIL is used. Some *engines* also carry this guarantee policy.

Available in Canada through Radiator Specialty Company of Canada Ltd., Toronto 2, Ontario, Canada

EMEROL MFG. CO.

242 West 69th Street New York 23, N. Y

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

RECTOR type "M"

..the Tubing Head that's WAY ahead

..in Flexibility

MANDREL HANGERS

Type "A" Mandrel Hanger threaded for EUE or regular tubing.

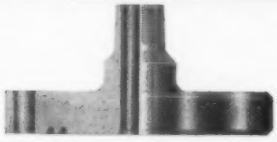
Type "M" Stripper for tubing heads with locking screws.

Type "A-O" Mandrel Hanger threaded, also grooved for locking screws. The "O" Ring serves as temporary seal.

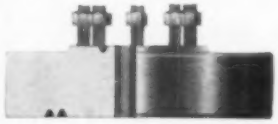
Type "WM" Wrap-Around Mandrel. It is hinged to wrap around tubing; also grooved for locking screws.

Type "C" "Slick Joint" Mandrel grooved for locking screws. The "O" Ring serves as temporary seal.

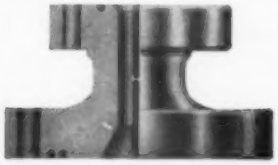
BONNETS



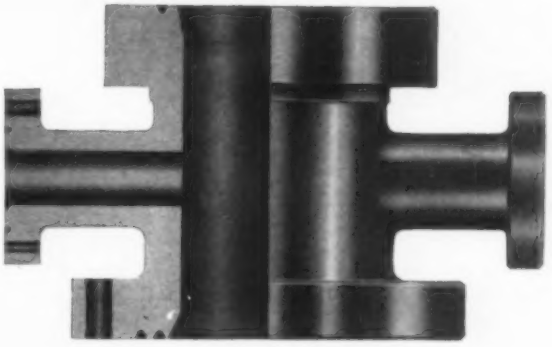
Male threaded bonnet also available with underside female threaded to hang tubing.



Studded bonnet also available with underside female threaded to hang tubing.



Spool-type bonnet also available with underside female threaded to hang tubing.



The wide range of body types (6), the complete range of pressures (2,000 to 15,000 lb. test), the variety of mandrel hangers and bonnets (10) . . . all of which are interchangeable in the bodies, plus auxiliary equipment, make it possible to select a Rector Type "M" Tubing Head for every well completion condition and preference.

Every one of these heads employs the proven Rector principle of sealing with steel . . . a single API Ring Gasket acting dually as seal and hanger hold-down. There are no soft or resilient seals in these heads to deterioriate, burn out, freeze or contract in extremely low temperatures.

When planning well completions . . . specifying Christmas Trees . . . specify a Rector Type "M" Tubing Head for the utmost in safety and flexibility.

For complete specifications of all Type "M" Tubing Heads, Mandrels and Bonnets, see the Composite Catalog.

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MAKING THE OIL INDUSTRY SAFER

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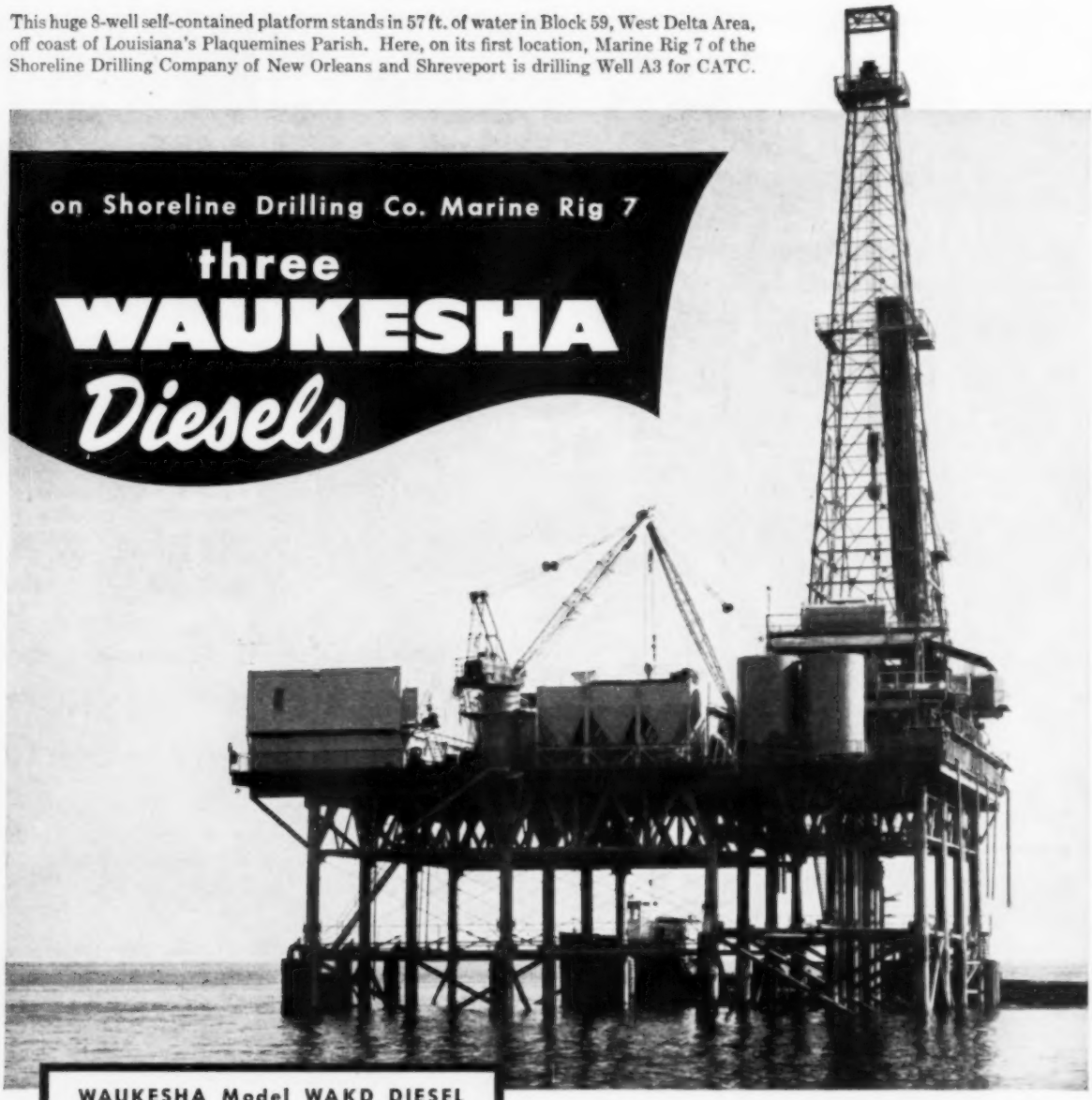
Houston Plant: 2215 Commerce St.

REPRESENTATIVES IN ALL ACTIVE FIELDS

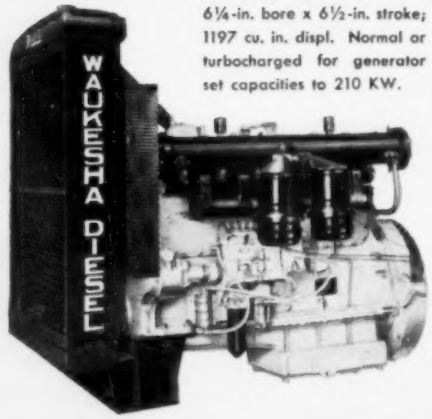
This huge 8-well self-contained platform stands in 57 ft. of water in Block 59, West Delta Area, off coast of Louisiana's Plaquemines Parish. Here, on its first location, Marine Rig 7 of the Shoreline Drilling Company of New Orleans and Shreveport is drilling Well A3 for CATC.

on Shoreline Drilling Co. Marine Rig 7

three WAUKESHA *Diesels*



WAUKESHA Model WAKD DIESEL



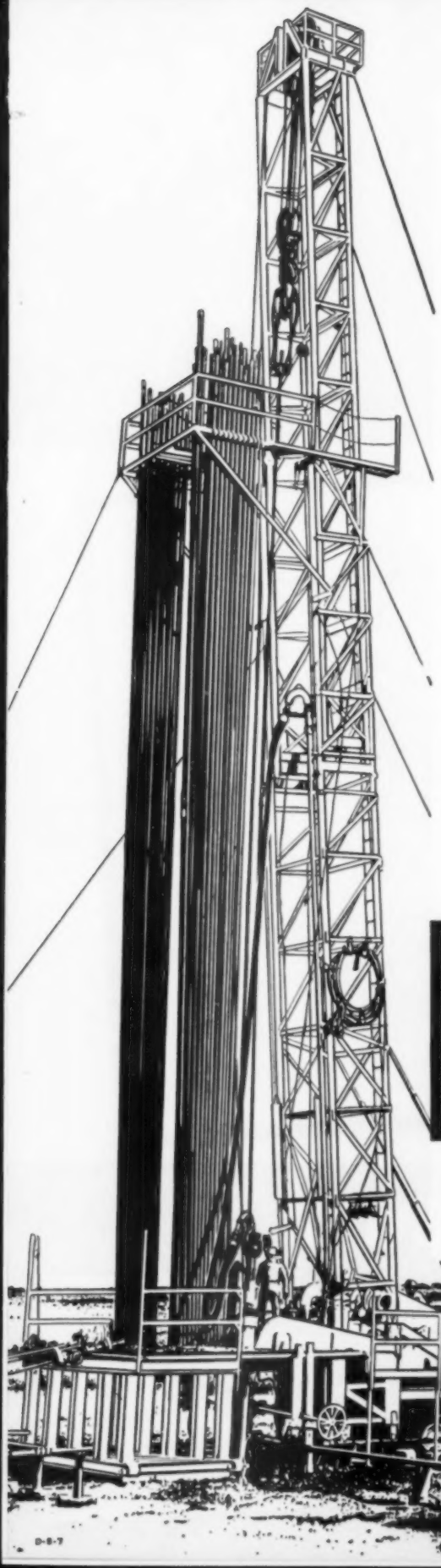
6¼-in. bore x 6½-in. stroke; 1197 cu. in. displ. Normal or turbocharged for generator set capacities to 210 KW.

337

each of the three 100 KW auxiliary power plants has its Waukesha WAKD Diesel

On Shoreline's Marine Rig 7 . . . a modern marvel of packaged efficiency . . . dependability is more important than ever. That's undoubtedly why Waukeshas were chosen for the auxiliary power plants. The power performance and rugged reliability of Waukesha Power has been repeatedly proved for every oil field need. Send for bulletins on Waukesha WAKD Diesel Series. *Waukesha Motor Company, Waukesha, Wis., New York, Tulsa, Los Angeles.*

WAUKESHA Engines and Power Units: 10 hp to 1135 hp—LP Gas • Natural Gas • Normal and Turbocharged Diesels—Get Bulletin 1079



Complete...with every 'extra' built right in!

cardwell trailerig

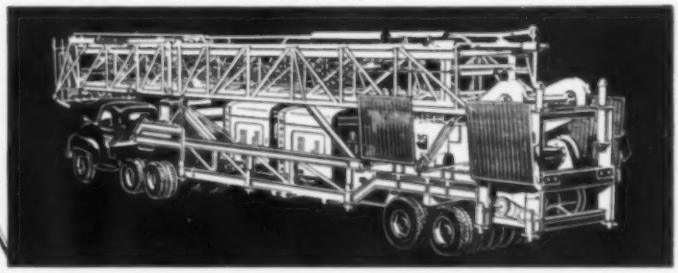
CHOICE OF SINGLE OR DOUBLE ENGINE...TORQUE CONVERTER OR MECHANICAL DRIVEN VERSIONS

Fast-moving . . . fast-operating . . . economical—for complete flexibility in conventional drilling, slim hole drilling, servicing or work over. Completely unified, this Cardwell design combines rugged draw works elements into a bridge-type trailer frame. Unit includes a 103-foot tubular or a structural type four-leg telescoping mast. An outstanding rig—with high strength-to-weight ratio—packed with outstanding field tested and proved features!

THESE FEATURES STAND OUT

★ MUD PUMP DRIVE (optional) in twin-engine mechanical version becomes an integral part of the engine compounding arrangement. ★ CATHEAD SHAFT is located ahead of the driller for added safety. ★ MAST PIVOTING does not interfere with well head connections. ★ AIR ACTUATED CLUTCHES used throughout. All controls centralized at platform for safe, convenient operation. ★ COMPLETE SAFETY-TYPE CONDUIT LIGHTING SYSTEM for trailer and mast. ★ SUB-STRUCTURE has ample blowout preventer clearance and does not require trailer ramps.

For full information: Call your Cardwell Representative.

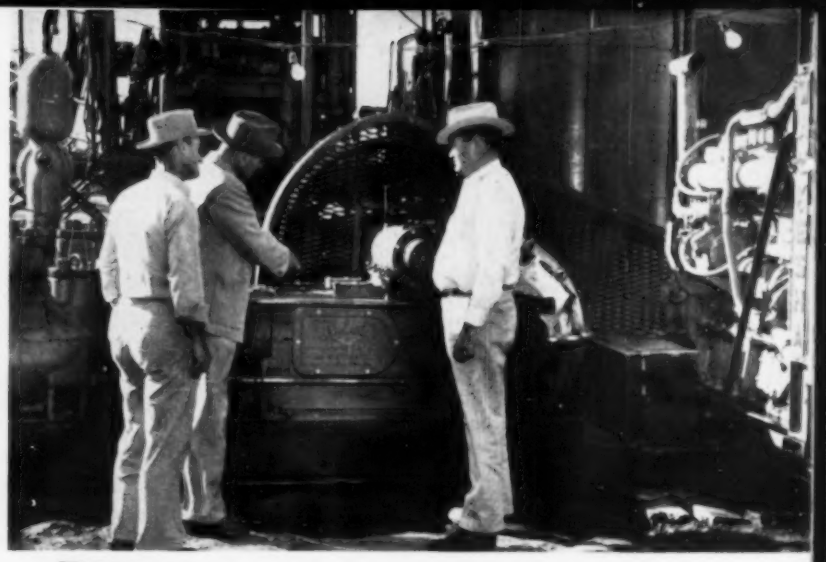


cardwell MANUFACTURING COMPANY

BOX 2001 • WICHITA, KANSAS, U. S. A.

D-8-7

In 11 months' continuous operation, no down time and no expense on this Dependable Wheland HP-8000 Pump !



Installation view of the Wheland HP-8000 owned by Virgil Taylor Drilling Co., Gainesville, Texas. Left to right: Mr. Woody Atkins, Tool Pusher; Mr. Virgil Taylor; Mr. Walter Smith, Drilling Supt.

WHELAND HP-8000
DUPLEX SLUSH PUMP
7¼" x 12"
220 HP at 70 RPM

Known throughout the oil fields as

"the biggest little pump on the market"

"We are happy to recommend the Wheland pump," says owner operating his second.

"Since . . . last January . . . have been running this pump within 10% of its efficiency. We have had no down time and no expense . . . during this time."

Wheland builds a Complete Line of Efficient Slush Pumps. **Write for Descriptive Bulletins.**

VIRGIL TAYLOR
WALTER L. SMITH
H. R. THECK

VIRGIL TAYLOR DRILLING COMPANY
PHONE
POSTOFFICE BOX
GAINESVILLE, TEXAS

November 15, 1956

Mr. Gordon P. Street, President
The Wheland Company
Chattanooga, Tennessee

Dear Mr. Street:

We purchased a Wheland HP-8000 Pump last January which has been in continuous operation since that time. We have been digging wells from 3,500 to 5,000 feet and have been running this pump within 10% of its efficiency during this work. We have had no down time and no expense against this pump during this time.

We had one of your old-style HP-11000 Wheland pumps in operation for a period of seven years. It is surprising to realize the amount of hole that it did with very small expense. We are happy to recommend the Wheland pump.

We operate two rigs in North and West Texas and in Southern Oklahoma, digging wells from 2,000 to 8,500 feet. We do contract drilling, take interest deals and drill for our own account.

Yours very truly,

VIRGIL TAYLOR DRILLING COMPANY

By Virgil Taylor
Virgil Taylor

WHELAND
ROTARY DRILLING MACHINERY

THE WHELAND COMPANY
CHATTANOOGA, TENNESSEE, U.S.A.
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We're saving $600 per rig monthly on wire line alone-

...Since our hoists were LEBUS GROOVED! *

If your rigs were *losing* $600 per month you would certainly come to a quick decision . If your rig isn't LeBus Counterbalance Grooved you CAN be losing money. You can actually save many hundreds of dollars by installing LeBus Counterbalance Grooving and Spooling System. Why? Because LeBus Grooving* means you'll have correct spooling with less vibration, reduced wire line whip, no line scrubbing and pinching, plus no hand spooling. This also adds up to increased drilling efficiency, greater saving of time and labor, with more safety to the crew. Consult your LeBus Engineer . . . Today!

*LEBUS COUNTERBALANCE SPOOLING

PERFECT SPOOLING "COUNTERBALANCE"

The World's Most Perfect Method of Spooling Wireline

Patent Nos.: Counterbalanced Spooling, Nos. 2,734,695; 2,732,150. Controlled Parallel and Helical Spooling, Nos. 2,708,080; 2,620,996. Appli. of grooving, Nos. 2,599,926; 2,204,938. Removable End Fillers, No 2,216,819. Other patents pending.

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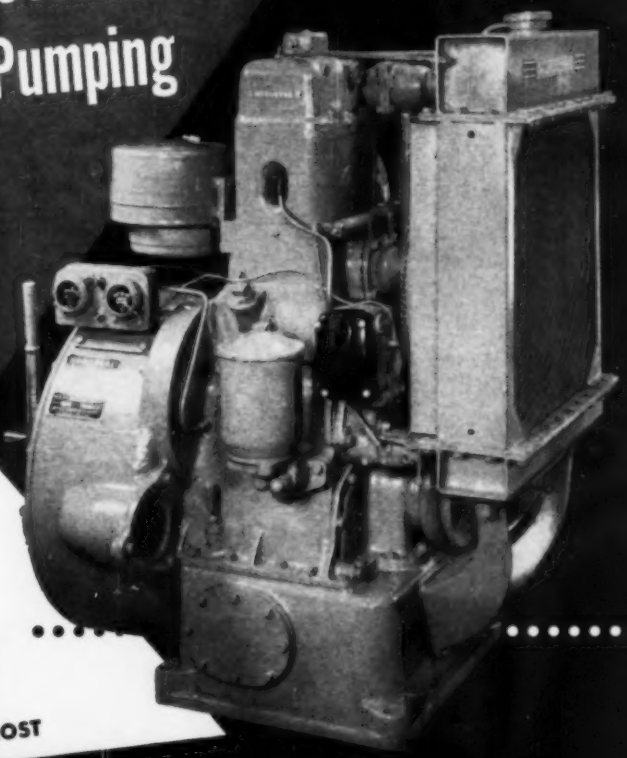
Executive Offices, Sales, Services & Warehouse • Longview, Texas

OVER 31,000 HOURS OF CONTINUOUS OPERATION WITHOUT AN OVERHAUL

. . . a typical Production Pumping record for



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LONG SERVICE LIFE • LOW MAINTENANCE COST

Over 31,000 hours of continuous operation with the original rings, piston, liners, bearings and crankshaft still in place . . . this is typical of the service histories of many Nordberg Power Chief engines now on rugged round-the-clock production pumping schedules.

With their heavy duty construction, Power Chief engines deliver smooth, steady performance—no surging or laboring during the power stroke which saves wear on clutch, V-belts and pumping unit gears.

These features alone mean more "money in the bank" when you use Power Chief Engines. Add to this the many "extras" that are included as standard equipment and you will see why you save by specifying "Power Chief".

For complete specifications and descriptive literature, clip the coupon below and mail today.

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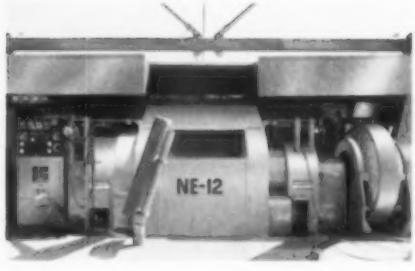
NE-12

OVER 45 YEARS EXPERIENCE

Mr. Arthur

(Coral Drilling Company)

ANOTHER BREWSTER EQUIPPED SEAGOING GIANT



BREWSTER NE-12—20,000-ft. diesel-electric drawworks expressly designed for offshore drilling.

Brewster is among the first to recognize the need to build a drilling rig that meets the highly specialized requirements of platform operation. Designed for the job offshore, the big Brewster NE-12 drawworks on Mr. Arthur's deck is a true seagoing drilling rig. Diesel-electric powered, the drawworks has two 625 h.p. motors mounted on the short main skid. At the drum, the driller has four hoisting ratios to supplement the infinite speed range possible with electric motors. Capable of 20,000-foot drilling, the Brewster drawworks has the reserve power to go on down on even deeper wells. Every component, from the short easy-to-skid drawworks package to the simplified control panel, has been carefully planned to provide maximum power, control and flexibility . . . all in the smallest possible deck space.

While your new offshore venture is still in the planning stage . . . call in Brewster for experienced designs in diesel-electric offshore drawworks.

BREWSTER

BREWSTER OFFSHORE DRAWWORKS

NE-12

EFFORTLESS CONTROL of every operation by the driller is made possible through a simplified control panel. His full attention is centered on the job to be done which promotes faster drilling and greater crew safety. Mounted on the main skid, the control panel moves as an integral part of the drawworks package.

1250 HORSEPOWER at the drawworks is provided by dual input drives from two 625 horsepower electric motors. The two-speed transmission, coupled with high and low drives at the drum, gives four hoisting ratios to supplement the infinite speed range possible with the electric motors. Short in length, the drawworks package requires a minimum of deck room . . . can be skidded around to permit 6 or 12-well drilling.

FLEXIBILITY of equipment arrangement is of major importance on space-limited offshore platforms. Mr. Arthur is equipped with these two D-1000 series mud pumps which were unitized with 650 h.p. motors. They can be skidded in the most favorable position for manifolding to the mud lines. Only an electric cable need be laid to obtain full driving power.

COMPLETELY PACKAGED the diesel-electric sets occupy a minimum of space . . . can be placed anywhere on the platform without regard to drawworks or pump locations. Individually skidded, they need only connection to fuel lines to go to work.

MR. ARTHUR'S "KING SIZED" MEASUREMENTS

Length over-all	*180'0"*	*Bottom to helicopter deck*	*102'0"*
Width over-all	*151'0"*	*Bottom to top of mast*	*240'0"*
Draft under tow	*7'6"*	*Drilling Complement*	*44 men*

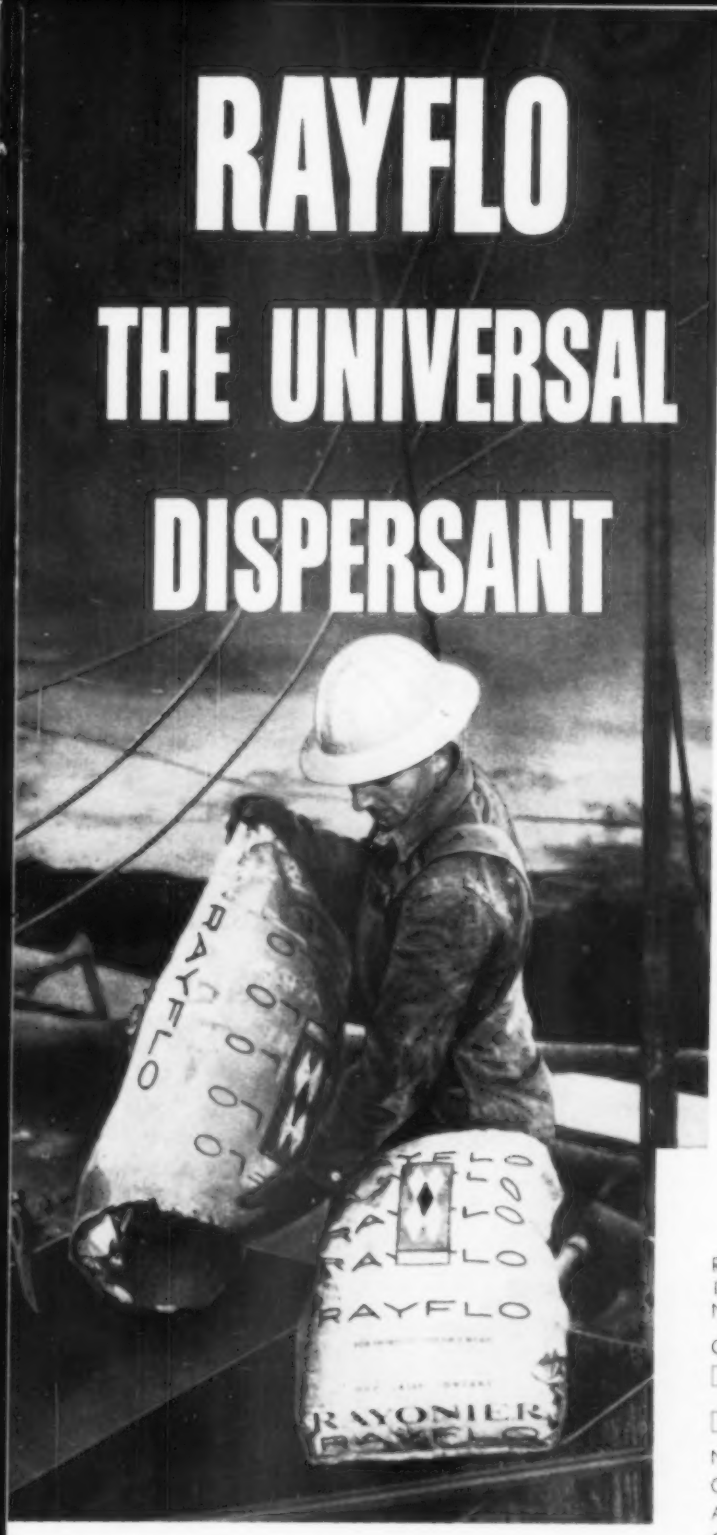
SUPPLY HOUSES

Howard Supply Company • Apex Equipment Company • Bovaird Supply Company • Industrial Supply Company • Murray Brooks, Inc. • United Supply and Manufacturing Company • Export Sales: The Brewster Company • (HOMCO) Houston Oil Field Material Company, New York, N. Y., Houston, Texas; Mexico City, D. F.

THE BREWSTER COMPANY, INC.

Shreveport, Louisiana

RAYFLO
THE UNIVERSAL DISPERSANT



Rayflo cuts drilling costs effectively. Thoroughly laboratory tested, it's been proved over and over again in the field . . . and is accepted world-wide!

outperforms all other mud dispersants!

SAVES STARCH—*Proved in Alberta, Canada!*

RESISTS SALT CONTAMINATION—*Proved in Southeast Texas!*

EFFECTIVE IN LOW LIME MUDS—*Proved at wells in Ventura, California area!*

HIGH TEMPERATURE STABILITY—*Proved near Bakersfield, California!*

REQUIRES LESS CMC—*Proved at offshore sites in Gulf of Mexico!*

EFFECTIVE WITHOUT CAUSTIC—*Proved in Venezuela—where caustic is objectionable!*

Especially designed to control the viscosity and gel strength of drilling muds, this dark reddish-brown free-flowing powder (chemically a polyphenol derivative) offers unique advantages to contractors, tool pushers, well drillers and operators.

Rayflo resists salt, gypsum and cement contamination; controls properties of sea-water mud; and is an excellent oil emulsion stabilizer. It is completely uniform and fully effective even under conditions of low alkalinity.

Rayflo is made in the United States by Rayonier, a leading world producer of chemical cellulose, and in Canada by Rayonier's subsidiary, Alaska Pine & Cellulose Limited.

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NEW

ECCENTRIC DRIVE
Reduces bearing pressure. Pressure lubricated.

DOUBLE HELICAL GEARS
Provide smooth, quiet power transmission.

Gardner-Denver triplex pump puts more power on well service Trucks

This newly designed triplex plunger pump (PA-8K) enables you to mount *more power* on your trucks for more economical cementing, acidizing and fracturing operations—*while staying within load limits.*

The underslung jackshaft of this new pump makes these advantages possible. This more compact pump is more easily mounted, and the jackshaft is brought in closer connection with the truck's PTO. Power transmission is smoother and pumping operations more efficient.

Over-all size and weight are reduced—width: 57⅛" . . . length: 85⅞" . . . weight: 6350 lb. Write for complete details.

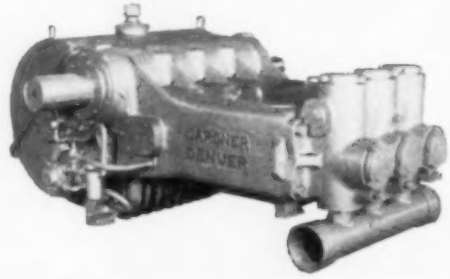
THREADED VALVE COVERS
Save on valve inspection time. Interchangeable.

SPECIAL SERVICE PLUNGERS
Available in various materials to meet service requirements.

Specifications for PA-8 and PA-8K Pumps

Pump	Jackshaft	4½" Plunger		4" Plunger	
r.p.m.	r.p.m.	g.p.m.	p.s.i.	g.p.m.	p.s.i.
175	825	290	1550	228	2000
150	705	248	1820	195	2300
125	587	207	2180	163	2750
100	470	165	2730	130	3470
75	352	124	3640	97	4650
50	235	83	5400	65	6950
34	160	56	8000	44	10000
Gal. per Rev.		1.65		1.31	

4½ x 8 triplex plunger pumps with upper jackshaft (PA-8) also are available.



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Results of fracturing using Adomite and lease crude

Well	Formation	Gallons Fracturing Fluid	Pounds Sand	Injection Rate BPM	Production, BOPD Before	After	30-60 Days After	6 Months After
A.	San Andres	10,000	10,000	5	2	28	35	—
B.	San Andres	15,000	21,000	5	4	54	120	65
C.	Springer Sand	6,000	12,000	3	8	49	51	51
D.	Penn. Cgl.	6,000	6,000	4	*	345**	144	80
E.	Miss. Chat	6,000	12,000	10	Dead	435	306	192
F.	Miss. Chat	6,000	10,000	5	10	—	33	30
G.	Miss. Chat	6,000	12,000	10	*	—	330**	360***
H.	Clear Fork	10,000	[illegible]	[illegible]	[illegible]	—	90	51
I.	Sussex "A"	[illegible]	[illegible]	[illegible]	[illegible]	63	45	52
						9	180	99
						9	67	51
						0	80	68
							49	30

More than 10,000 success stories fracturing with Adomite

Adomite® — and only Adomite does so many things so effectively!

Seals the fracture face . . . minimizes fluid loss . . . no damage to formation.

Longer fractures . . . deeper penetration of sands.

Fewer sandouts . . . reduces fluid loss in rock matrix, prevents buildup of sand concentrations in the fractures.

Saves you money . . . utilizes your own lease crudes . . . saves transportation costs

Decreases friction loss . . . low viscosity of Adomite-created fracturing fluids permits use of less pumping equipment than with viscous refinery residuals.

Reduces hazard of emulsions . . . emulsion-breaking characteristics are important consideration to many producers.

Adaptable to virtually all types of crude, Adomite is all you need to control fluid loss of kerosene, crudes, gelled crudes or refinery residuals.

Producers who say Adomite . . . stay with Adomite.

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Get greater profits from your next fracturing job

TELL YOUR SERVICE COMPANY TO USE Adomite

Why this pile of sand means lower drilling costs for a South Louisiana operator

The sand in this picture is part of nearly 1500 barrels that a Dorrco D-Sander removed from the mud in drilling one well in South Louisiana. Notice the sharpness of the cliff-like edges which show that the D-Sander not only removes coarse sand but also a great deal of silt and drilled clay solids.

As a result of this, pump parts last longer, bits drill faster and last longer, drilling time is reduced and the cost of mud chemicals is lower.

In one series of controlled comparisons a Dorrco D-Sander saved an average of more than 5,000 dollars per well. Because of savings like this, more and more contractors are installing Dorrco D-Sanders as standard equipment on all their rigs.

Write for Full Information.

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A Sid Richardson Development Company

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(FORMATION FRACTURING TOOL)

The gun that shoots 'round a corner!

Welex called this mighty innovation the Formation Fracturing Tool when they developed and introduced it two years ago — you, in the field, gave it a new name after using it — the Bear Gun. By any name — oil operators everywhere are calling more and more for the tool's great fissuring power in their tough wells. Wherever the formation or a heavy invasion of mud or cement hinder the flow, call Welex for the Bear Gun. Each shot will give you a large entrance hole — deep into the formation — and the extensive fissuring that reduces pressures and makes your fracturing job a success!

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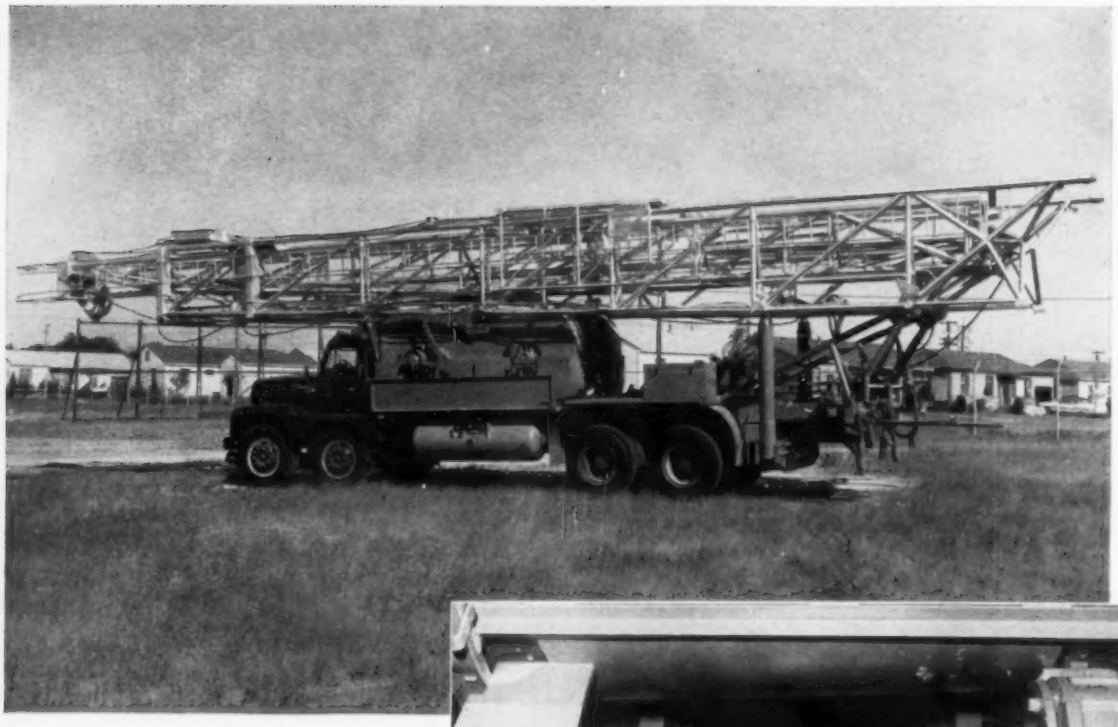

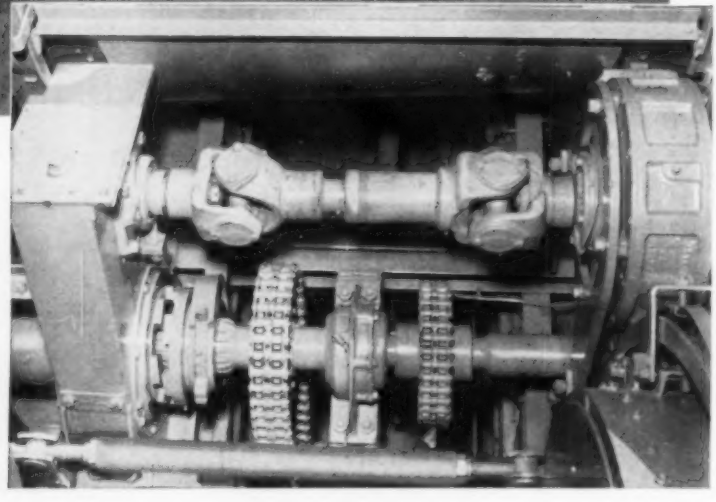

Driving the draw-works—
Rex Roller Chain.

REX®

Roller chain on the Franks Rocket Rig

Have a look inside this Franks Rocket Rig (Franks Division, Cabot Shops, Inc., Drawer 3216, Whittier Station, Tulsa). You'll see Rex Roller Chain driving its draw-works.

Why Rex? Rex pitch control assures equal load distribution over all parts—and greatly extended chain life. Rex manufacturing has added tremendous strength at the pin holes. Rex glide-fit design makes assembly and disassembly fast and easy.

Why Rex? It's the very best of all the good roller chains—best design, best materials, best manufacture to the precision tolerances needed to keep your rig running around the clock.

CHAIN Belt Company, 4719 West Greenfield Avenue, Milwaukee 1, Wisconsin.

CHAIN BELT COMPANY

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CF&I SEAMLESS CASING AND TUBING

all over the Permian Basin...

Rig operators in the Permian Basin know from first-hand experience that CF&I is a desirable source for top-rate seamless oil country casing and tubing. For—ever since it opened its modern tube mill at Pueblo—CF&I has enjoyed the privilege of serving this important production and exploration area.

Oil men all over the West will tell you the same story. CF&I Seamless Casing and Tubing is top quality. CF&I controls every phase of operations required in the manufacture of its seamless casing and tubing—from the mining of its raw materials to the finished product. This step-by-step control assures a product of high quality.

Available in standard sizes from 2⅜" to 9⅝" O.D., CF&I Seamless Oil Country Casing and Tubing meets or exceeds API STD 5A specification. Ask your CF&I representative for the complete story today.

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THE COLORADO FUEL AND IRON CORPORATION

Denver, Colorado

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when you must be SURE

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P 422.91

Present staggering investments in tidelands oil will be paying off in 15 years — from offshore wells averaging 12,400 ft deep, being completed at the rate of 1200 to 1500 annually

C. R. Graham,
Assistant Editor

PROVED oil reserve in tidelands areas along the Gulf and Pacific coasts are now estimated at 15 billion barrels. From all indications, only the surface has been scratched. Offshore wildcatting is 44 percent successful, highest ratio in any part of the U. S. Offshore oil and gas production is prolific. Oil companies, both major and independent, are hoisting their hip boots and "loading for bear."

Future of offshore oil and gas development *looks* bright. The potential is vast. Knowing that oil is somewhere under all that water, however, won't find it, or produce it, or make a place for it on the market, or afford it a justifiable price. Problems encountered in the tidelands oil search have been endless and are far from solved. In spite of all complications, oilmen continue to pour money on top of money — now estimated at $1.5 billions—into these operations. Return on this staggering investment is at least a score of years away.

Known Factors

Oilmen are at best playing a long shot to make money in the tidelands. The full story is yet to unfold. Known factors are few. Operators are putting full faith in the high oil discovery ratios, the large number of good structural prospects and big reserves.

Variable Factors

Estimated reserves of oil and gas are anybody's guess. No one will know how much is to be had until every mile of the 18,000 miles of coastline has been drilled. "Ifs" in the offshore oil picture are many. If leasing continues uninterrupted, with a justifiable return on investment, activity will continue to grow. Several factors influence tideland activity. Among the most important will be ownership of Louisiana tidelands, rate of offshore allowables, and availability of steel and other materials. Negative variable factors include a tight money situation, as exists today, shortage of qualified personnel, a lack of demand for domestic crude, and unavailability of cheap transmission outlets.

Unknown Factors

Most of the oil development factors are completely obscured from view — and the fact that the oil is underwater has nothing to do with it! Anyone's guess is good as to who owns much of the tidelands along the Louisiana coast. Who knows what effect oil imports will have on payout of the offshore investment? Who can predict ideal offshore drilling units needed to meet 1965 requirements?

The Fortunate Fifty

Fifty-odd companies have taken stock of the known factors, figured the mean and extreme of the variables and waded boldly into the unknown, investing some $1.5 billions in the offshore game.

A look at major oil companies and

Mobile platforms, used primarily for exploratory drilling in Gulf waters, now number 36 —mostly owned by drilling companies. This is the Offshore Company's No. 55.

Large self-contained platforms can drill up to as many as 12 wells from one location. This type structure is used to develop a field after mobile units and small platform-tender combinations move on to virgin territory.

independent operators who are now active in tidelands operations are all pretty good bets as to the group who will make money on offshore oil in the years to come. Snowballing lease costs and increased equipment costs are making it increasingly hard for newcomers to get into the game. Each new lease sale sets new high records for acreage bonuses; each new barge and platform seems to double in cost.

For example, Louisiana sold its first leases in 1945 — some 129,000 acres — at $5.10 an acre. In April 1956, the state accepted bids totaling $13,395,907 on acres. Today's average is about $380 an acre—and much of the acreage is for land that bears no clear title, but lay in the zone under dispute between the state and federal government. If operators hold these leases, the rental fee is 50 percent of the bonus per acre. Some Gulf Coast lease bonus costs are running as high as $1220 per acre; bid offerings on California offshore lands have already reached $1500 per acre.

Costly Offshore Experience and Expense

Costs Doubling

Equipment costs have skyrocketed, too. In the past 10 years of offshore operations, a 12,000 ft rig has increased in price from $400,000 to $800,000 — pushing other prices upward with it. An 80-ft crewboat that in 1947 cost $22,000 is now modestly priced at $107,000; surplus LCT's have been revalued from $30,000 to $1,250,000. These price increases are for similar pieces of equipment for drilling in similar depth ranges. As offshore activity ambles seaward into deeper water, costs multiply. Submersible barges for 35-ft depths cost $2,000,000; one company is now building a $6,000,000 rig to operate in 100 ft water.

What's the payout? No one knows just how long today's equipment will be in service, or what the effects of corrosion will be, or when they will become obsolete.

There are no "poor boy" operations. By no stretch of the imagination are offshore operators making ends meet.

To date, oil companies have reaped a slim harvest of $250,000,000 on their $1.5 billion investment. Finding people to loan "a few million bucks" isn't as easy as it used to be, producers tell us. The tight money situation in the U. S. today hasn't excluded offshore oil people.

Figuring oil payout is "calculated guesswork." Rate of depletion allowance, field longevity, allowable rates, crude prices, equipment depreciation, and production and transmission costs must all be considered. One company has ventured an estimate, however, based on an initial investment of

Seismic work in the Gulf of Mexico is one of the few vital expenses in the offshore oil search that may still be had at a "bargain" price. This is a Shell Oil Company crew.

$634,000,000. This company figures that it would take 14 years to return the investment — if all went well. Assuming it had production that would last over a 36-year period, the venture would bring an average yearly return of about 10 percent.

Well drilling costs continue to rise in line with increasing equipment and pipe costs. A recent series of events involving barge safety and longevity have brought hints that insurance rates to drilling contractors would be hiked, thus increasing actual drilling costs. This is one expense that in the past has consistently held the line against inflation. Depth of the offshore oil discoveries, alone, are prohibitive to many. Gulf Coast offshore wells average 9700 ft (2½ times the U. S. average depth).

And, expenses are incurred long before the drilling rig gets on location. Seismic and geophysical prospecting must precede any activity. There's no such thing as surface geology.

Marine geophysical surveying, however, is perhaps the only phase of offshore activity that is costing less today than similar onshore work.

Geophysical costs per mile of traverse are relatively low, about ¼ to ⅓ the average onshore costs. The cost of finding a first-class prospect, particularly an unleased one, is also relatively low. The entire Louisiana-Texas offshore can be surveyed to a water depth of 120 ft for $15,000,000—a little less than 90 cents per acre—with the possibility of finding 100 unleased structures generally conceded to be firstclass projects, in addition to gaining valuable structural background and finding many additional anomalies that may produce. Perhaps this one fact alone is responsible for more offshore activity in spite of all deterring factors.

Presence of good drillable structures, in quantity, have enabled companies to find oil with a lesser number of exploratory wells than in any other region in the U. S. One reliable source states that three fourths of the offshore fields have been discovered by the first wildcat.

Ira Cram, senior vice president, Continental Oil Company, who is in good position to know the facts, states that "if proved reserves (Gulf Coast: 620,000,000 bbl of crude, September 1, 1956) happen to be calculated on the same basis as API reported reserves — they are supposed to be—the reserves per average offshore wells have been in line with average costs. In other words, available data indicate the average offshore well, including dry holes, has found eight to nine times as many hydrocarbons as the average onshore well and has cost eight or nine times as much."

Drilling platforms used in conjunction with a tender, form a successful offshore drilling combination. Although platforms and most tenders are owned and maintained by oil operators, drilling contractors rigs and personnel are predominately used to "get the wells down."

This is reason enough for the big offshore gamble.

The Find

Of the 1450 wells drilled offshore in the U.S., 32 percent were dry. Some 25 percent of the development wells have been found dry. In the 11½ years of offshore drilling in this country, 38 percent of all wells in the U.S. (onshore and off) were dry. Mr. Cram points out these additional facts: "As of January 1, 1957, 243 new field wildcat wells drilled on 137 prospects had resulted in the discovery of 82 fields, 74 of which are off the coast of Louisiana. Based on production of the discovery wells, 35 are classified as oil fields and 47 as gas fields. Further drilling will undoubtedly change this classification. Thirty-four of these wildcat wells have produced; 39 percent off Louisiana, only 15 percent off Texas. Year in and year out the national batting average is a little over 11 percent. The record looks still better when one recognizes that a far higher percentage of the Louisiana offshore discoveries are giant fields or will probably turn out to be."

Boom Towns

Don't think, however, that oil companies are the only ones who realize the potential that lies in offshore oil and gas development. Once-sleepy towns and cities along the Gulf Coast have turned their attention to servicing, supplying, feeding and housing the host of oilmen who followed oil activity to the water's edge.

There are 6000 persons employed in the drilling segment in Louisiana offshore operations alone. Demand for new personnel in this area has intermittently moved ahead of supply, to the point that some operators are forced to delay the drilling of new wells. On the whole, the oil industry has brought new prosperity to many. Obviously, the "prosperity point" has not yet arrived for the debt-laden oil operators themselves and drilling contractors with large capital investments.

The Uninvited

"Three (other) well known outfits have done very well, however," says the Conoco vice president. "The State of Texas has collected $47,500,000 in lease bonuses, the State of Louisiana over $121,500,000 and the federal government almost $247,000,000. Add to these amounts royalty and rentals and one finds that the states and federal government have made over one-half billion dollars thus far—tax free."

Judging from these figures, the groups that have the most to gain in the shortest period of time have also proved, paradoxically, to be the most deterrent factors.

Slowdown

Louisiana, where the oil finding prospects are brightest, and the federal government have been at odds

Pacific Driller No. 1 is the first mobile platform to arrive on the West Coast scene. It may have a full year's wait before it is allowed to begin a full-scale drilling program. It is now core drilling in the Santa Barbara, California, beach area.

Drilling islands are used for California offshore drilling, and has for years been the only approved method in Pacific Coastal waters. This island is in the Seal Beach, California, vicinity.

since 1945 over who is to have jurisdiction over the offshore waters, and to what depth. This dispute was brought to a head in 1953 by the passage of the Submerged Lands Act. This law granted to states all submerged land "seaward . . . three geographical miles from the coastline of each state and to the boundary line . . . where such boundary as it existed at the time such state became a member of the Union extends beyond three geographical miles . . ."

Texas claims that its "historical boundary" is actually three marine leagues, or about 10.5 miles out. California has argued less about its boundary limits, since depths at the water's edge drop to several hundred feet — for the most part excluding much offshore drilling as it is known on the shallow Gulf Coast.

Louisiana has been a little less definite about its boundary claims, and has drawn about six different lines along its indefinite shoreline. It was this dispute that put a clamp on all offshore leasing and drilling along the Louisiana coast last June. Marks of this calm of leasing and new drilling, in connection with the order, are still visible. Only in October 1956 was a truce called to permit drilling to continue on leases already held by oil companies within the disputed area.

Louisiana's case was again before the Supreme Court in April for a final settlement. This settlement, to date, has not yet come.

Tools for the Offshore Trade

Differences of opinion have arisen concerning the future activity in the tidelands as a result of ownership litigation and the many other factors involved. Industries outside the oil world, however, must gage their materials production in this field by the needs of the industry. To meet the tremendous demands for steel within the rising offshore oil industry, United States Steel Corporation has conducted a survey to enable it to meet these future needs. This survey has illustrated, by its own very conservative survey, the need for expansion within the steel industry. U. S. Steel claims that tidelands activity will demand 700,000 tons of steel a year by 1970. Less than half that amount is being given the drilling industry to build the platforms, boats, drilling tenders, and tubular goods needed. Other phases of the oil industry requirements account for the remainder.

Activity Forecast

Well completions, according to U. S. Steel, are expected to number 570 this year—rising annually until the five-year period of 1966-1970 when completions are expected to number 1200.

According to other predictions based on oil company records and plans, well completions in 1957 are expected to number over 700. This would approach the activity expected by U. S. Steel in 1959. If these latter predictions hold true, the offshore industry may find itself wanting for steel supplies, an intermittent oil industry problem for years.

Speaking for U. S. Steel, Henry J. Wallace, a vice president of the National Tube Division, in a talk before Southern District API in March, predicted this activity: "By 1965, 1000 wells and 10,000,000 ft will be drilled annually in the Gulf of Mexico; and by 1970, it is probable that nearly 1300 offshore wells will be drilled each year—about 5 percent of total domestic footage. In 1956, offshore drilling was only 2 percent of domestic drilling."

Drilling Units

"To support this level of activity," Wallace continues, "225 offshore platforms and nearly 80 tenders should be in operation during 1970, compared to 130 platforms and 45 tenders currently in operation. This reflects increasing use of the tender method for exploration and self-con-

tained platforms for development. . . . The platform used with the tender can be readily converted to the self-contained type by placing an identical platform next to it and adding cross members. All three broad groups of drilling methods—mobile, self-contained, and tender-minimum platforms — of course will have certain advantages; but we believe that future exploration from the mobile platform will be principally on lower chance locations, where it will reduce expenses in moving to a new site. Only on rare occasions will development wells be drilled from this type of platform.

"What will such expansion in offshore drilling mean in terms of steel requirements? To build platforms alone, 65,000 tons of plates, structurals, and tubular steel will be required annually over the next few years; and this demand will grow steadily to 120,000 tons by 1970. These steel islands are, of course, only part of the total offshore market. Transporting the platforms, drilling supplies, and crews between the well site and shore installations means special marine equipment, ships, and barges. We believe that at least 220 crew boats will be built in the next 14 years, plus 50 supply boats, and more than 300 cargo barges, many of special design to float platform components to lease sites. In addition, mobile crane units with the largest lifting capacities available will be required to put the platforms in place. This fleet of specialized vessels, in several different designs, will require nearly 140,000 tons of steel from 1957 through 1970 — about 10,000 tons a year."

Drilling Platforms

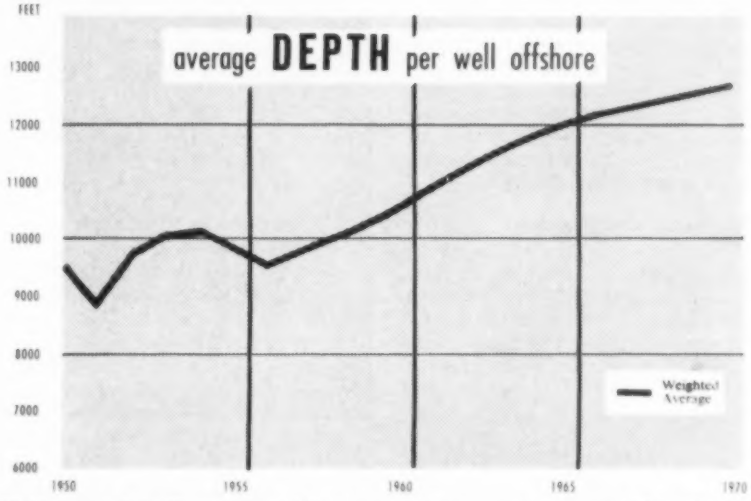
What kind of drilling platform will best do the job today, tomorrow and in 1970? Who will own them? How deep can they drill now; how deep will they need to drill in 1970? Who can afford them?

The U. S. Steel survey suggests that the mobile platform is now in its heyday. Some 36 of these units are now in operation or under construction and will meet the needs of exploratory drilling for the next five years. U. S. Steel predicts that one additional mobile unit will need to be built in each of the years 1961-1965, and an additional three units per year during 1966-1970.

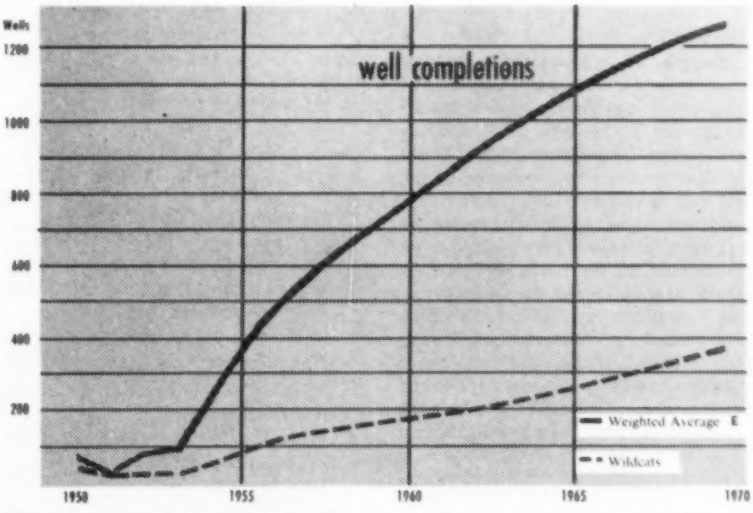
Demand for these mobile units are expected to slow down as drilling moves to deeper water and exploratory drilling gives way to follow-up development drilling in the years ahead. How will this affect the drilling contractor?

Conservative completion forecast by U. S. Steel is considered low by many offshore operators. Many are predicting that over 700 wells will be completed this year — nearing the 1959 mark shown here. — Courtesy U. S. Steel

	1957	1958	1959	1960	Normal Year 1961-1965	Normal Year 1966-1970
Well Completions	570	650	720	780	960	1,200
Average Depth	9,700′	10,050′	10,300′	10,600′	11,350′	12,400′
Footage (in thousands)	5,530	6,530	7,410	8,270	10,900	14,880
Exploratory Wells	125	145	160	170	200	305



Offshore well depths are about 2½ times the U. S. average. Current offshore depth is 9700 ft, and is expected to reach 12,000 ft before 1965. — Courtesy U. S. Steel



Well completions in the Gulf of Mexico are expected to reach 1200 per year before 1970. The area will then provide the U. S. with an estimated 5 percent of its domestic crude supply. Current share is about 2 percent. — Courtesy U. S. Steel

The mobile platform has been the key stronghold of the drilling contractor in offshore activity. Some 25 of these units are owned and operated by contractors today. Remaining 11 are owned and operated by oil companies or oil company groups.

Will prohibitive costs of small-platform-and-drilling-tender combinations and self-contained platforms force the contractor from the field?

New mobile platform designs continue to be unveiled in an attempt to meet current disadvantages. These drawbacks, says U. S. Steel, include: (a) High cost of daily operations narrows an already thin profit margin; (b) Since they are not permanently located, their vulnerability to unfavorable weather is increased; (c) The limitation in the depth of water in which they can now drill is a restriction to future use, and (d) Maintenance of dispersed wells is higher in cost.

Drilling contractors' rigs will continue to dominate the field—as onshore — although they may rest on oil company-owned platforms, serviced by oil company owned tenders.

Platform and Tender

Forty-seven tenders are in operation or under construction. Conversions include 19 LST's, 11 YF's and one tanker; 16 were built specifically for offshore drilling. Day rates are reduced 15 to 40 percent by cheaper financing involved in a ship-like tender, self-propelled or not, indicates U. S. Steel. Also, savings in daily operational expenses are possible by owning instead of contracting, some operators feel.

All but 13 are owned by major oil companies or combinations of companies. Cost of minimum platforms is enough to be covered by the working capital of major oil firms. As these exist today, however, several disadvantages exist. First, cost of recovering the platform on a dry hole and moving to a new site is almost as expensive as a whole new structure. Too, the deeper the water the more difficult it is to anchor a tender securely, and the size of the platform has to be increased to give proper stability. Also, extra expense of marine equipment and ship's crew must be absorbed.

Success of the combination drilling unit lies in the 70 percent success ratio achieved in Gulf waters. Development is possible using the small platform by skidding the rig a few feet and drilling three to five additional wells. Adding to the popularity of this unit is the flexibility given by the possibility of adding additional sections if warranted by the size of the oil strike.

Self-Contained Platforms

U. S. Steel predicts that the majority of future offshore wells will be completed from self-contained platforms. There are now 37 in the Gulf, all owned by oil companies or groups of companies. Daily operational expenses are less with this method than any other, and to date, as many as 12 wells are being drilled from one platform. Their use, however, because of size and related cost, must be restricted to well-proved areas.

Production Techniques

Production engineers have been fast to adapt themselves to tidelands operations in spite of its many new problems. Well control, communication, corrosion and gathering problems confront the operators.

Offshore operations have introduced wells with tremendous wellhead pressures. New equipment has been developed to meet these needs. Dual and triple completions are cutting costs to help trim well payout time.

Control, communications and maintenance of wells as many as 50 miles from shore have posed new problems. Completely automated control systems are meeting these demands. Microwave systems may prove the answer to future needs.

Corrosion mitigation in the salty Gulf of Mexico is still a major problem, and only time will tell the effectiveness of existing methods. Recent developments are encouraging and drastic cost reductions have been made in mitigation.

Weather has multiplied the problems of the production crews. Stormy seas have and will continue to play havoc with the routine remedial and maintenance work that is a part of every lease operation.

Lease oil gathering is leading the field in automation practices. Laying these pipelines to producing wells introduce new problems to production men and pipeline personnel.

New Outlets, New Uses, and New Areas

Transmission

Because of offshore pipelaying expense, such operations are undertaken with extreme caution to insure return on investment. Until reserves are justified, produced crude is taken to storage facilities by way of barge, an expensive operation. In the case of natural gas, where pipeline is the only outlet, a sufficient number of wells must be proved before pipeline facilities may be extended to an area. As a result, a great number of shut-in wells exist today. Complicating this situation is the large number of gas-condensate producing wells found in the offshore areas. To produce the high gravity condensate, the gas must also be produced.

Natural Gas, Petrochemicals

Pending before the Federal Power Commission, who controls the fate of all interstate natural gas production, are several plans to develop offshore gas reserves. If these plans, initiated by oil and transmission companies are approved permitting adequate price and rate of take, a big push in this activity may be expected. Between six or eight different lines are in the planning stage to service the offshore fields in the Gulf of Mexico.

To increase the flow of natural gas from offshore wells has been the joint efforts of many companies to set up new petrochemical plants along the coast. One such venture is Petroleum Chemicals, Inc., organized by Continental Oil Company and Cities Service Oil Company.

Florida is looking with eager anticipation to develop and promote new petrochemical plants. Plans have been made to provide the state with sufficient natural gas pipelines to open this field of activity.

California Activity

Added to the proved offshore prospects along the Gulf Coast is a substantial portion of the Pacific Coast, where California drillers have for years been probing under the water by use of artificial islands and shore-based horizontal drilling techniques.

Although local municipalities have been permitting offshore drilling on their properties, the State of California has turned thumbs down to every proposal yet put before it to explore and develop its tidelands.

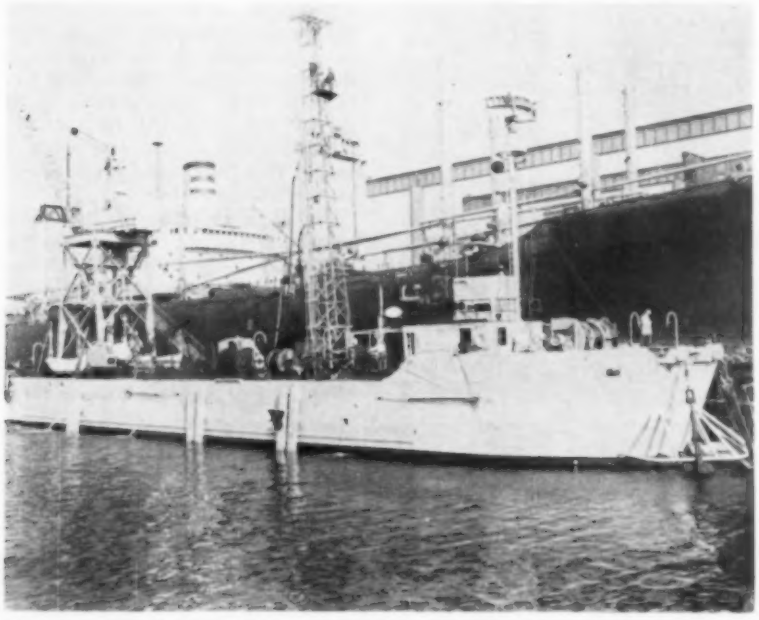
Core drilling is being done through ship bottoms and just recently the first full-size mobile platform (the Pacific Driller) arrived on the West Coast scene.

Still, no full-scale drilling is permitted.

Current stumbling block to Cali-

fornia offshore activity involves the amount of royalty that will be required from the oil producers. The state legislature is split "down the middle" as to whether the royalty should be 12½ percent, or 16⅔ percent, or should be a flexible amount based on a sliding scale. In other states, Texas requires 16⅔ percent and Louisiana requires a minimum of 12½ percent. Federal government has asked and received some at 16⅔ percent and some at 12½ percent. In all cases, however, the royalty fee has always been a flat one—never a sliding one.

Several bills to get California offshore activity moving are under consideration. It is a fact, however, says the State Lands Commission, that if any legislation is immediately passed, leasing cannot possibly get underway for at least a year, due to lease evaluation and processing.



Offshore drilling barge — California style. This converted LSM is used to test drill along the West Coast. Drilling is done through the ship bottom.

Production platforms like this one in the South Pass, Block 24 field, dot the Gulf Coast. Automated equipment has made production control and maintenance easier, safer, and more economical. — *Courtesy U. S. Steel*

In the meanwhile, California finds itself importing about 200,000 bbl of oil per day, onshore drilling discouraging, diminishing, and with reserves fast declining.

No Offshore License

Other states are quick to point out that Texas, Louisiana and California do not have a monopoly on offshore drilling. Success of offshore drilling, now proved possible and with a chance of proving economical, has brought other areas to re-examine inshore lakes and adjoining waters.

Great Lakes drilling is no longer a dream. Ohio, Michigan, Pennsylvania, New York and Canada have already set up rules for permitting over-water drilling. Within the past few days Texas Calgary Company has announced plans to drill in the oil-proved waters of Lake Erie. Other companies are looking to offshore drilling in Lake St. Clair in Michigan and Ontario.

Gulf Coast barge-building shipyards are now designing and supplying offshore drilling equipment for use the world over.

Glamor Is Over

Conoco's Vice President Cram says, "The experience to date has been intoxicating. Explorers have had a wonderful time boasting of their batting averages and reserves—of the reliability of their crystal ball. Companies in on the ground floor have been sticking out their chests. Hard-boiled production men with firsthand knowledge of the problems of turning prospects into profits have been less noisy, but even they are pleased that they are now doing the 'impossible' such as drilling wells in 112 ft of water as far as 64 miles from shore.

"The glamor is wearing off, however. All operators, whether pioneers or newcomers, whether lucky, unlucky-but-hopeful, or just hopeful know they have at least one problem in common—doing everything more cheaply. Back-breaking work to make back-breaking investments pay off is the order of the day."

Without a doubt, as always in the past, oilmen will solve their mechanical problems and will lick the weather, corrosion and all the other allied offshore headaches. Future of offshore development then, lies within the action of local, state and federal governments, who have as much if not more to gain by offshore development as the oil industry itself.

Henry J. Wallace adds this: "Is this a great bubble that one day must burst? Actually there is no bubble to burst! This is just hard, realistic, good business." ★ ★ ★

THE "Vinegarroon," second three-legged self-elevating mobile drilling barge, was commissioned recently by Zapata Off-Shore Company at New Orleans, Louisiana, and immediately departed for its first drilling site in the Gulf. Initial operations will be in 35 ft of water 15 miles off Cameron Parish, Louisiana, for Sun Oil Company.

The new 2500-ton tripod drilling rig, patterned after its forerunner, Zapata's revolutionary "Scorpion," was fabricated by R. G. LeTourneau, Inc., Longview, Texas, at the firm's Vicksburg, Mississippi, manufacturing site. Prior to its christening, the rig was towed by three tugboats from Vicksburg to New Orleans where final outfitting of the derrick was completed. Deck area is more than half an acre, and operating weight when fully loaded will be as high as nine million pounds.

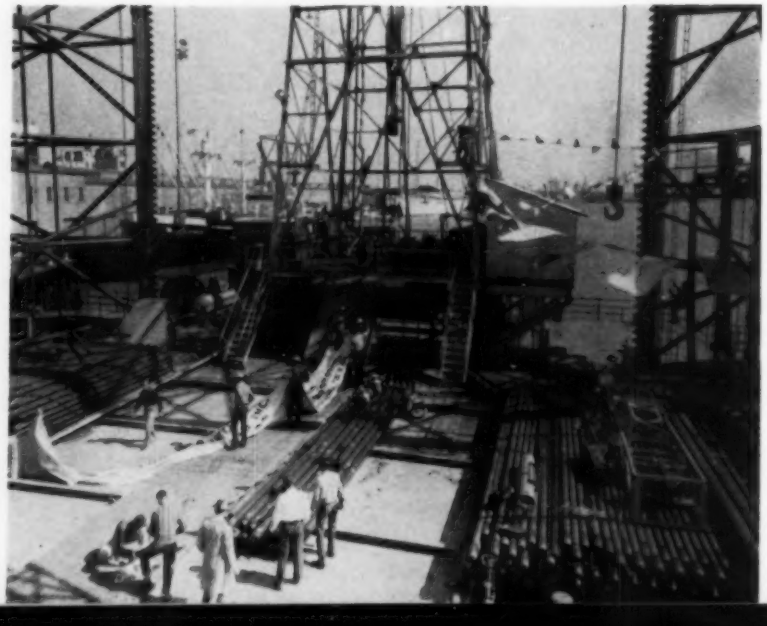
Although similar to the "Scorpion" in basic design, the "Vinegarroon" incorporates changes that will afford it even greater mobility than its predecessor model. Cost was reported to be $3,250,000.

Electric-powered legs. The "Vinegarroon" is a triangular, floating barge,

The "Vinegarroon"...

Newest Tripod Drilling Barge Joins Offshore Fleet

Zapata Off-Shore Company's second tripod self-elevating mobile unit cost 3¼ million, can drill in 100 ft water. Required four million pounds of steel



The "Vinegarroon," newest tripod self-elevating mobile offshore drilling barge at christening ceremonies at New Orleans dock side. (Above) Note helicopter deck atop triangular leg at left. **Elevated rig floor** (Right) sets at stern of triangular-shaped barge. Foreground deck is for storage of drill pipe and casing.

equipped with three electro-mechanically controlled spuds or legs. Giant legs, each operating in 36-ft spud wells, lower to the ocean floor when located over a drilling site, elevated the hull structure to the desired height above the water. The legs are 145 ft in height, equivalent to a 10-story building, and are made of truss-braced tubular steel, combining strength and rigidity, with the ability to adequately minimize the effect of heavy seas. Three gear racks are mounted integrally on each of the legs, and are driven by final drive pinions actuated by LeTourneau Electric Gearmotors.

Feet of the elevating legs are spud tanks 35 ft in diameter, and 32 ft high, which are filled with water when the legs are lowered. Having concave bottoms, the spud tanks are designed to provide a sure grip in securing dependable footing on the ocean floor.

Powering the three supporting legs are 27 electric motors, nine in each spud housing, which drive the legs through 6000-to-1 gear reductions, and derive power from three 440-volt, 60-cycle, 3-phase a-c generators. Power for the generators is provided by three turbocharged diesel engines, each developing 600 (max) hp at 1200 rpm. One of these engine generator combinations supplies power for ship's service, as well as providing stand-by power for lowering the legs.

Sufficient power is supplied by the power equipment to allow all three legs to be raised or lowered simultaneously, an improvement over the "Scorpion's" capacity to operate only one leg at a time. Fully loaded, the new rig may be raised at a rate of 16 in. per min, and lowered at 18 in. per min. Average height of the platform above the water during drilling will be approximately 40 ft.

New barge shape. The "Vinegarroon's" triangular shape is in contrast to the rectangular configuration of the "Scorpion," a design modification which its designers feel will afford greater maneuverability when the barge is being moved between drilling sites.

The "Vinegarroon's" platform hull is 176 ft long and 151 ft wide, with a depth of 20 ft. Loaded draft of the rig is 11½ ft. Hull sides and outer bottom are made of corrugated steel. Deck structures and platform inner bottom are fabricated of flanged steel plates. Between the platform's double bottom are arranged compartments for the storage of drilling water, potable water, and diesel fuel.

Drawworks below floor. Major items of drilling equipment are located below the floor deck where it is protected from the weather. The main drawworks is rated at 1600-hp input, and is driven through torque converters by four diesel engines, each rated at 520-hp intermittently at 1200 rpm. These four engines are also compounded into the two main mud pumps located below the floor deck. Each of these large heavy-duty pumps is rated at 1000 input hp at 65 rpm. A smaller pump on the same level is rated at 650 input hp at 65 rpm.

A smaller drawworks, rated at 350-input hp, is separately driven and is located on the floor deck to drive the rotary table and perform all sand line and cathead operations, independent of the main drawworks located below deck. Driller's control console is located on the floor deck from which position he is able to control all equipment in the drilling operation. Drilling platform and 140-ft derrick are located on the rig's stern and are elevated above the main deck.

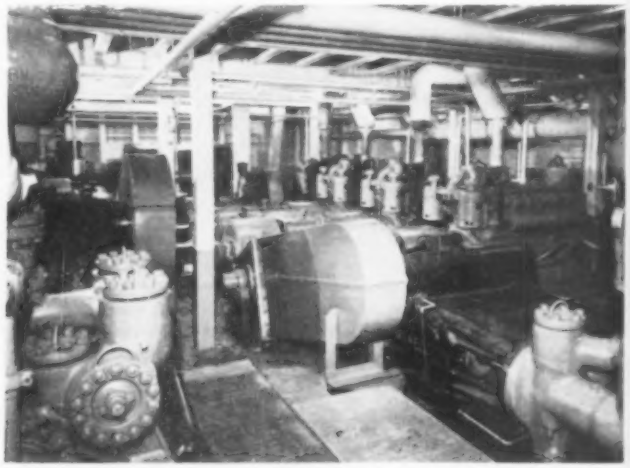
An open-end drilling slot allows the derrick and drilling floor to slide back to clear the completed well when moving off location.

Other features. Two 300-ft-ton revolving cranes are installed on the platform deck, aft of the crew quarters, servicing deck and hold areas, and sliding in materials handling. Three anchor winches, each having a 50,000-lb line pull capacity, are located on the platform deck, and are used in positioning and mooring the platform.

Air-conditioned quarters and living facilities for 45 men are integrally built into the rig's stern on three levels. A control office is located over the living facilities, from which is exercised central control of the platform during elevating, lowering, and towing operations. An intercommunication system connects key locations on the rig with the control office. Rounding out the platform's complete communication system is a short wave and ship-to-shore telephone, also installed in the control office.

Predecessor doing well. The "Scorpion," the first mobile drilling platform to be introduced into the off-shore industry, has written a successful drilling history since her commissioning in March 1956. Having completed six wells, she is presently working on her seventh, for the California Company, in the Gulf of Mexico, a few miles from New Orleans.

Main mud storage compartments at left have a capacity of 1500 bbl of liquid mud. Dry storage at right is for 10,000 sacks of dry mud materials.

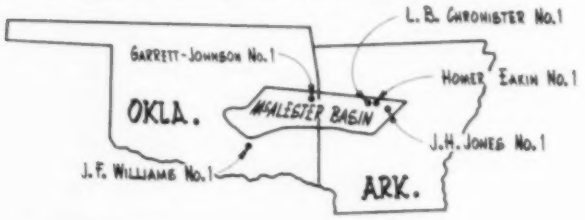


Main mud pumps and auxiliary pump are located on main deck below elevated floor. Main drawworks is also located here (background).

Acknowledgment

Photographs of the "Vinegarroon" were generously furnished by Oil Well Supply Division of U. S. Steel Corporation, who supplied major items of drilling equipment, and Caterpillar Tractor Company, who provided the engines. ★

FIG. 1. **McAlester Basin Area** of Oklahoma and Arkansas, showing location of five wells drilled with air and gas.



In the McAlester Basin Area of Oklahoma and Arkansas

Air and Gas Drilling Cuts Costs 22 Percent

On five wells, 14,409 ft of hole drilled. Average penetration rate increased 184 percent; average footage per bit increased 630 percent

J. H. Adams, *The Carter Oil Company, Seminole, Oklahoma*

ROTARY drilling with air or gas as a circulating medium has been highly successful in drilling four wells in the extremely hard-rock area of eastern Oklahoma and northwest Arkansas. An over-all saving of 22 percent was realized by utilizing air or gas rather than conventional rotary mud. One application of the exhaust-gas drilling technique was not as successful from an economic standpoint.

When comparing this new drilling technique with mud drilled wells, the average penetration rate was increased by 184 percent and the average footage per bit was increased by 630 percent. Optimum rotary speeds of from 40 to 60 rpm provided a bit life of from 300 to 350 ton-hours while drilling through the hard Atoka shale. Air velocities below 2000 ft per min were insufficient to remove cuttings at depths below 4700 ft. This drilling technique has definite limitations and disadvantages. Formation water continues to be the principal obstacle to be overcome.

Up until the time that air or gas drilling was introduced, cable tools were used extensively in this extremely hard-rock country. A common practice when standard tools were not used to drill from top to bottom was to drill to a depth of from 3000 to 4000 ft with cable tools and then move in rotary tools to finish the well. This drilling technique was highly successful at three wells, was not an economic success at one well, and the fifth well is an active drilling location. The locations of the wells are shown on the map, Fig. 1.

Originally titled "Air and Gas Drilling in the McAlester Basin Area," this paper was presented at the Spring Meeting of the Mid-Continent District, API Division of Production, at Tulsa, Oklahoma, April 10-12, 1957.

Other advantages. In addition to the advantages already outlined, there were other direct benefits from employing this method. Formation permeability was relatively undisturbed when drilling into a production formation which was easily and effectively tested at all times while drilling. This advantage virtually eliminates the possibility of passing up commercial oil or gas production. Zones of lost circulation were penetrated without difficulty.

Limiting factors. This relatively new drilling technique has definite limitations and disadvantages. It is important that these be considered before air or gas drilling is undertaken. As yet, a quick inexpensive method to shut off formation water has not been developed. Therefore, shallow water zones may make air drilling impractical. If the hole is not mudded up for running casing, logging is limited to surveys that can be taken in a dry hole. In some areas these logs are not entirely satisfactory. In areas of soft or easy drilling, where penetration rates are high and drilling cost per foot low, air or gas drilling probably is not competitive. Thus far, this operator's experience in air drilling has been primarily limited to areas of high drilling cost.

Equipment

Drilling with air or gas requires only minor modifications to conventional rotary equipment. Typical installations and manifolding are available from the literature. Compressed air was supplied by trailer-mounted V-type compressors, each rated at 750 cu ft per min at 265 psig. Two compressors connected in

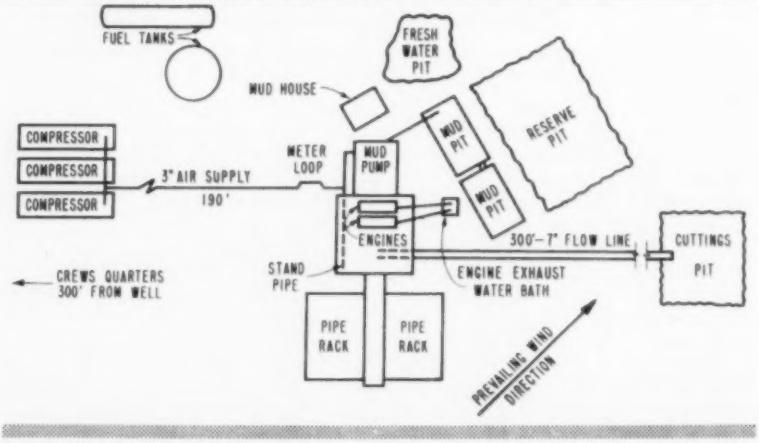


FIG. 2. **Drilling rig layout** showing relative position of all major components, and their relation to wind direction.

parallel were used to drill to a depth of 3500 ft in one well and to 4700 ft at the other well. Below these depths three compressors were used.

As a safety precaution, all equipment was strategically located to insure maximum safety at all times. This is illustrated in Fig. 2. Other safety features included explosion-proof lighting, spark-proof ignition system for rig engines, fire extinguishers, fans, spinning ropes in place of chains, and water baths for engine exhausts. Mud pits were maintained on a standby basis to kill the well if such action became necessary. In the event that production was obtained, a float was installed in the drill pipe to facilitate stripping out without mudding up. As an added precaution, a swivel valve was installed.

Individual Well Performance

The J. H. Jones No. 1, located in Conway County, Arkansas, was Carter's first experience in drilling with a gaseous circulating medium. At that time, from a safety standpoint, the industry had some reservations about using air for wildcat drilling. For this reason, exhaust gas was used. The application was limited to drilling three intervals totaling 1862 ft because of formation water and mechanical difficulties which made it necessary to convert to mud. Although penetration rates and bit performance were improved when compared with mud drilling, use of this technique involves additional expenditures for equipment required to cool and dry the exhaust gas and for prevention of corrosion. These expenditures are not required in the cases of air and gas drilling. Experience has shown that these latter two methods can be safely utilized with proper precautions.

The J. F. Williams No. 1, located in Atoka County, Oklahoma was Carter's first air-drilled well in this area. Drilling from under surface casing to the well's total depth of 5093 ft was an unqualified success. This is illustrated by the fact that only 39 days and 15 bits were required. By compari-

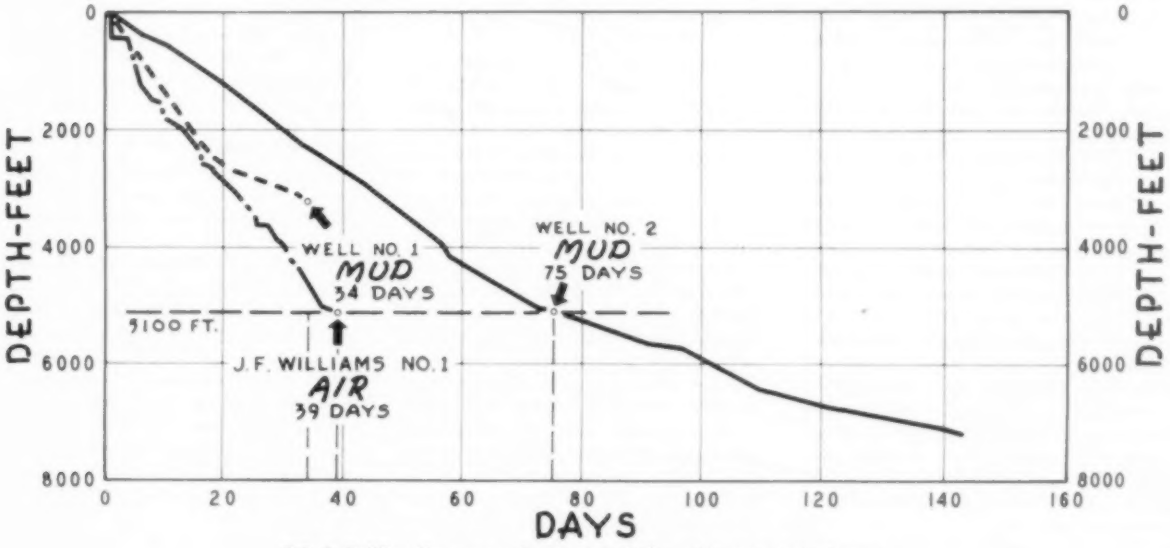


FIG. 3. **Drilling time curve** for the J. F. Williams No. 1 in Atoka County, Oklahoma, as compared to drilling time of nearby wells drilled with mud.

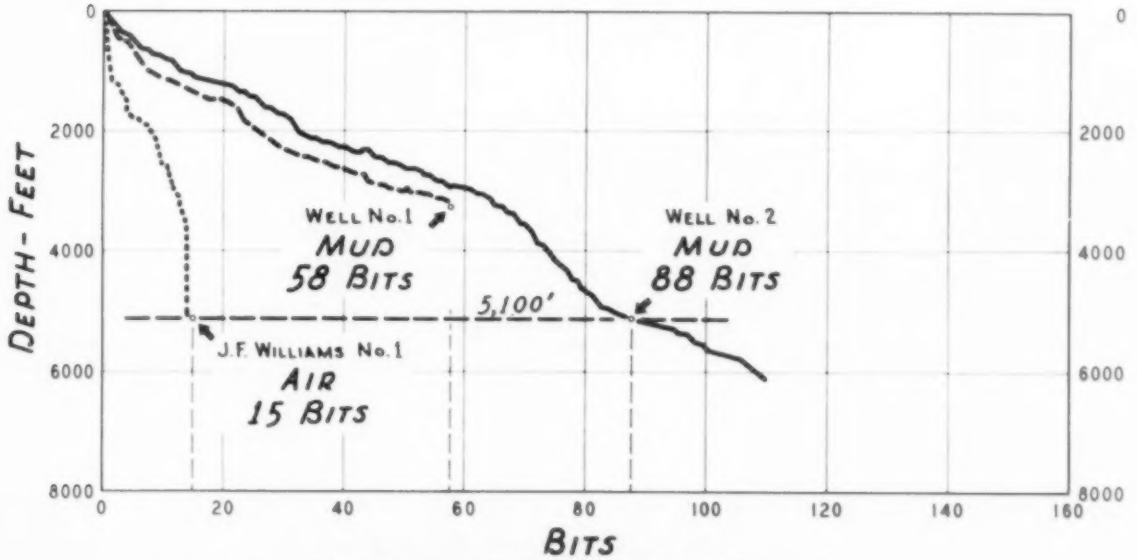


FIG. 4. **Bit consumption** in drilling the J. F. Williams No. 1 totaled 15, as compared to 88 bits on nearby well to same depth.

son, a mud-drilled well located in the same general area required 72 days and 89 bits to drill to the same depth. A comparison of the elapsed drilling time and the bit requirements for the J. F. Williams No. 1 and two nearby mud-drilled wells is presented graphically in Fig. 3 and Fig. 4. The average penetration rate was 6.9 ft per hr. By comparison, the average penetration rate for the nearby mud-drilled wells was 3.3 ft per hour or 52 percent less than that for the air-drilled hole.

The L. B. Chronister No. 1, located in the Moreland Pool, Pope County, Arkansas, was the second well drilled with air by Carter in the McAlester Basin area. Although it is difficult to make a valid comparison with nearby wells which used a combination cable-tool and rotary drilling technique, Fig. 5 presents a comparison of the elapsed time vs depth for this well and two nearby wells. A total of 79 days and 66 bits were required for the air-drilled well to a total depth of 5208 ft, as compared to an average of 115 days cable-tool time and 81 days rotary time for the two nearby wells to drill to the same depth.

The only difficulty experienced was a small water seep encountered below 3200 ft. The water volume was low and did not affect the penetration rate. However, it was sufficient to ball up the dust and create tight spots which were sufficient to stick the pipe. The hole size was subsequently reduced from 9⅞ to 8¾ in., and the 8-in. drill collars replaced with 6-in. drill collars. No further difficulties with moisture were experienced.

The third well to be drilled below surface casing to the total depth with air or gas was the Garrett-Johnson No. 1, located in the Cartersville Gas Pool in eastern Oklahoma. High-pressure natural gas was available for drilling this well. A cost comparison showed that a saving of 11.2 percent would be realized by using natural gas rather than compressed air. Drilling with gas proceeded to a depth of 5762 ft virtually uninterrupted, and required 29 days and 10 bits. The outstanding performance of gas drilling is illustrated by a comparison with nearby wells drilled with mud, shown in Fig. 6 and Fig. 7. These comparable wells averaged 54 days drilling time and required 63 bits to drill to the same depth. The average penetration rate with mud was 6.4 ft per hr as compared to 11.6 ft per hr for gas drilling.

The only difficulty experienced while drilling with natural gas was that of drying up the hole during the early stages of drilling. Gas from the transmission line was delivered to the well at temperatures ranging from 18 F to 45 F, which were insufficient to dry up the hole. An indirect gas heater was installed to raise the temperature to 85 F and the difficulties were corrected.

The Homer Eakin No. 1, also located in the Moreland Pool, Arkansas, was the fifth well to be drilled with air or gas in this area. At the present time this well is an active drilling location. Initially, natural gas from the offset L. B. Chronister No. 1 was used for circulation. However, the produced gas had a high content of fracture kerosine which was sufficient to ball up the dust and prevent returns. Installation of a combination separator and mist extractor did not correct the difficulty, and it was necessary to move in compressors and utilize air for the drilling fluid.

This well is of particular interest because considerable difficulties were experienced with moisture in the hole. The volume of water was only 1 to 3 bbl per hr, but drilling ahead with air was slow due to balling the dust and lack of returns to the surface. Often after trips, it was necessary to circulate from 12 to 14 hours to dry up the hole before drilling ahead. Because of this water problem, overall penetration rates at the Eakin No. 1 were considerably less than those experienced at the offset air-drilled Chronister No. 1. Use of a foaming agent or surfactant mixed in water and added to the air stream was very successful in alleviating the trouble. With its use, the hole would dry up in 1 to 3 hours and some dust was obtained at the surface.

Bit Performance

Operations at Williams No. 1 was Carter's first extensive experience with air drilling in this area. Rotary speeds were varied from 40 to 160 rpm and bit weights ranged from 2000 to 16,000 lb. It was observed that at speeds of over 60 rpm, early cutter failures were responsible for terminating the service life. At rotary speeds less than 60 rpm there was little wear to the cutters, and worn-out bearings were usually the cause of bit failure. The change in rotary speed had little or no effect on the penetration rates. Based on these findings, rotary speeds were held to the 40 to 60 rpm range.

While drilling in the thick Atoka

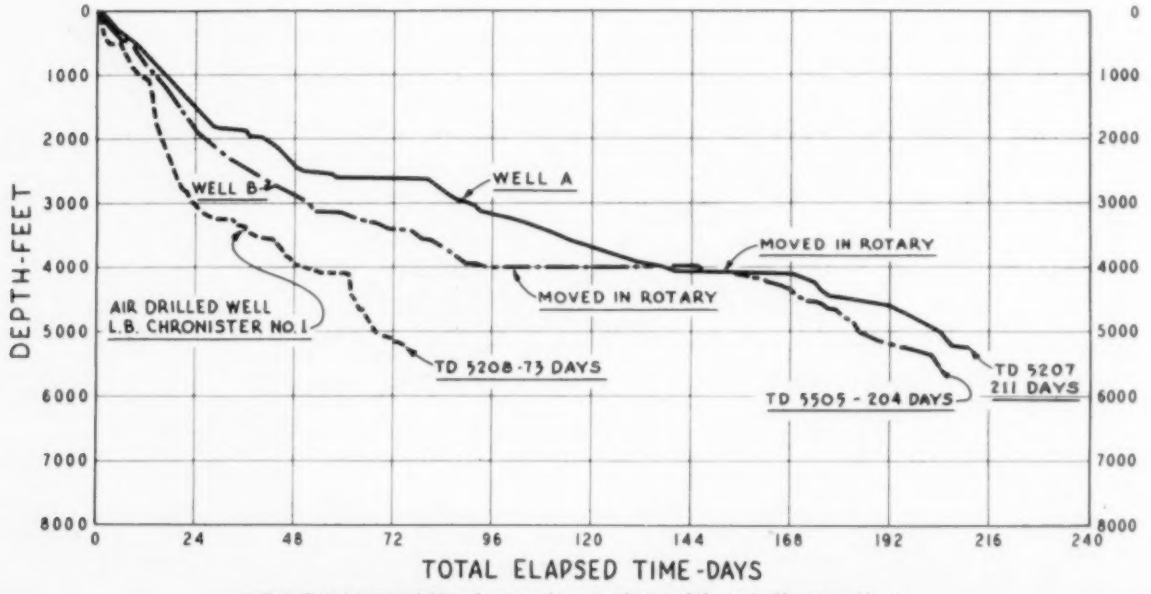


FIG. 5. **Total elapsed time** from spud to completion of the L. B. Chronister No. 1 as compared to nearby wells drilled with mud and completed by cable tools.

shales, common to this area, it was exceedingly difficult to determine when to pull the bit. Some bits were pulled that showed little or no wear, whereas others were worn down to exposing the bearings. Often, penetration rates were unchanged. Valuable rig time was lost while making unnecessary trips to check the bits. Careful records of rotary speed, bit weight, and time on bottom were kept. Based on these observations for two wells, it appears that the optimum rotary speed of from 40 to 60 rpm provides a bit life of from 300 to 350 ton-hours while drilling through the thick Atoka shale. Although longer runs of up to 500 ton-hours have been obtained, it is probably advisable to pull and check the bit at 300 to 350 ton-hours in this area.

Air and Gas Volumes

Air or gas velocities of from 2000 to 3000 ft per min have been generally accepted as the rate required to effectively remove the cuttings from the hole. Based on calculations at the Williams No. 1, two 750 cu ft per min, 265-psig rating compressors initially provided an annular velocity of 3890 ft per min. At a depth of 4700 ft, prior to adding the third compressor, this annular velocity had decreased to an approximate average of 1900 ft per min.

Hole size of the Williams No. 1 was based on a caliper survey which showed actual diameters ranging from 9 to 25 in. and averaging 12¼ in. At 4700 ft the 1900 ft per min velocity was insufficient to remove the larger cuttings, as evidenced by the finely powdered samples that reached the surface. The inability to remove the cuttings was further illustrated by the fact that, after circulating 2 to 3 hours before making a connection, as much as 100 ft of caving would be in the hole when drilling was resumed.

After the third compressor was installed, the annular velocity was increased to an approximate average of 2660 ft per min and the large samples were lifted to the surface. After increasing the velocity, the hole would clean up in a matter of minutes before making connections. This experience would indicate that because of the irregular hole size, accurate velocities cannot be calculated. Therefore, if the hole stays clean, the air volume is adequate; if not, additional capacity is needed. With a little experience, it is not difficult to determine if the cuttings are being effectively removed and the hole is clean.

Possible Improvements

The air-and-gas-drilling technique is still in the very early stages of development. This drilling method presents the same challenge to industry as did the development of rotary drilling with mud, which has made remarkable progress in recent years. Based on limited experience, some ideas for improvement are suggested.

As previously mentioned, only minor modifications to the rig equipment are required for air or gas drilling. This is true for the minimum requirements, but more efficient operations could be obtained by specialized equipment. As much as 50 percent of the total compressor horsepower was lost to friction in the stand pipe, rotary hose, swivel, kelly, and the 4½-in. drill pipe. By enlarging the inside diameter of this equipment, the results would be twofold: (1) Compressor horsepower could be reduced because of lower friction losses, and (2) Larger drill pipe would reduce the annulus area and thereby reduce the volume of circulating air required.

Rock bits of all types are not yet available that are specifically designed for air drilling. It is necessary to cut out the water course in conventional bits to avoid excessive pressure drop across the bit. Improved bit performance could certainly be obtained by research and development on a bit designed especially for air drilling. In selected areas reverse circulation may result in improved performance and reduced costs. Work is now under way on bit designs suitable for reverse circulation. Success may reduce the required compressor capacity by as much as two-thirds.

The field of additives to the air-or gas-circulation system is unlimited. Some of these may be improved foaming agents, bit lubricants, penetration stimulants, or well-sealing compounds.

A number of drilling contractors

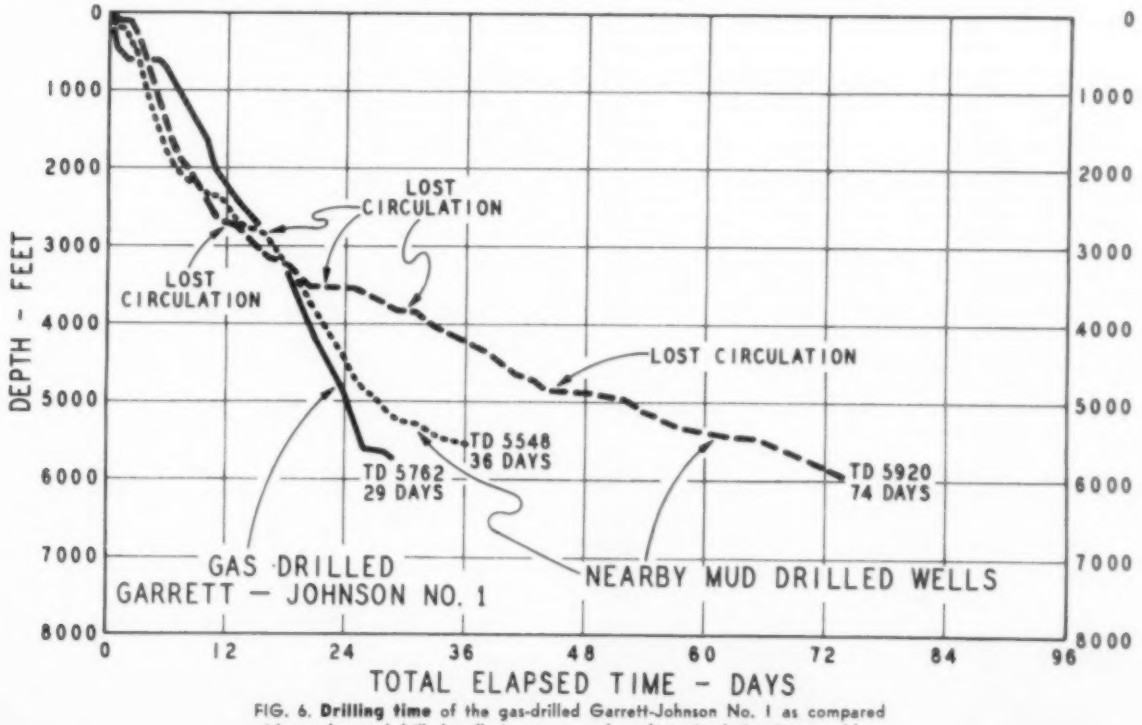


FIG. 6. **Drilling time** of the gas-drilled Garrett-Johnson No. 1 as compared with nearby mud-drilled wells in an area where lost circulation is a problem.

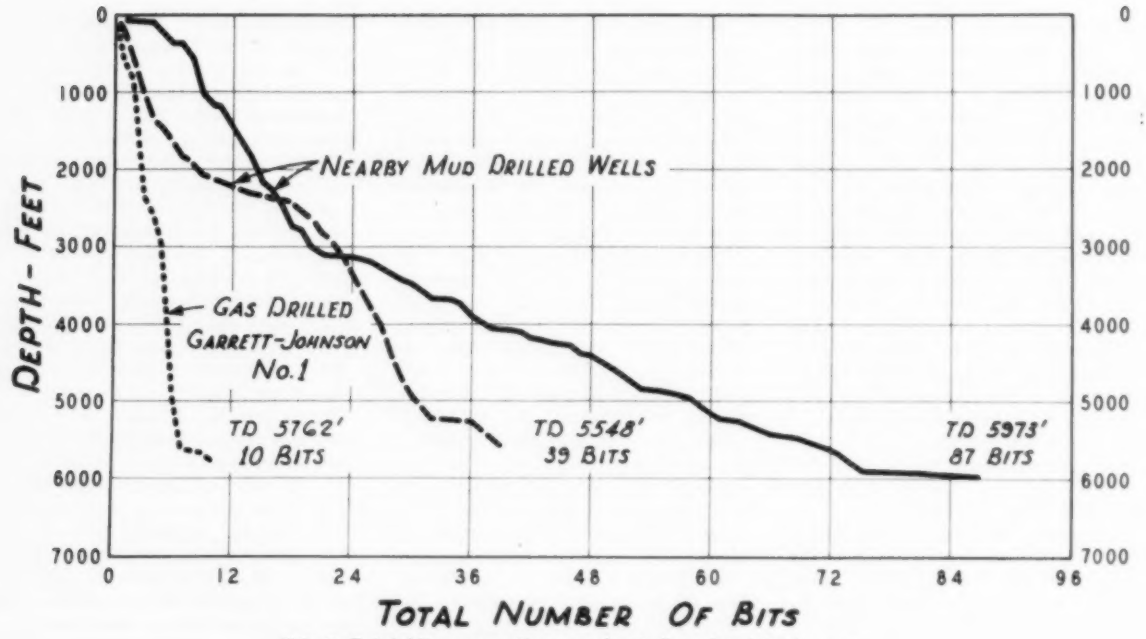


FIG. 7. **Total bit consumption** was drastically reduced in the gas-drilled Garrett-Johnson No. 1 compared to two nearby mud-drilled wells.

are equipping rigs with air compressors and a number of service companies have them available for rental. Even so, compressors of the proper sizes and pressure ratings are often not readily available. Quite often transportation charges on air compressors are high and prohibit their more frequent use. With continued use, proper-size compressors will become available.

Finally, and probably of most importance, development of a technique for handling and/or shutting off formation water would increase the opportunities for utilizing this improved method for drilling.

Acknowledgments

The author expresses his appreciation to the management of The Carter Oil Company for permission to publish this paper, and J. A. Kelley, E. M. McCain, C. R. Chambers, J. S. Bottler Jr., and S. N. Stearns for their valuable contributions. ★ ★ ★

R. C. Baker Retires, Culminates 63 Years of Service

R. C. Baker, chairman of the board and president of Baker Oil Tools, Inc. since its formation, has resigned as president after 63 years of activity in the oil industry. The announcement was made at a directors' meeting in Los Angeles in April.

The directors then elected as president and general manager, T. Sutter, who has served as executive vice president and general manager since 1930.

Following the election, R. W. Henderson, vice president and assistant general manager in charge of the company's central division, presented to Mr. Baker, on behalf of all employees, a full color photographic portrait. R. C. Anderson, a grandson, next presented a bronze bust of Mr. Baker created by Barnhart Lemmel, dean of the Art School at the University of Houston. These tokens of Baker employees will be permanently displayed in the Los Angeles office of the company.

Standing before a bronze bust, presented to him by his employees, R. C. Baker (right), retiring president, congratulates Ted Sutter, new president of Baker Oil Tools, Inc. Baker's retirement culminates over 63 years of active service to the oil industry.

R. C. Baker is truly one of the "old timers" in the oil industry, having started his career in 1894 driving a two-horse team hauling oil for $2 for a 12-hour day. By 1896 he was contracting the drilling of wells in the Los Angeles fields, and in 1899 commenced contract drilling of oil wells in the Coalinga area.

In 1907, Mr. Baker, as superintendent for several oil companies, introduced the first rotary equipment in the Coalinga fields by importing two rotary crews from Texas, where rotary operations had been initiated in 1901.

In 1907 he developed the Baker casing shoe, an invention upon which the company was founded. The Baker Casing Shoe Company, founded in 1913, purchased a machine shop in 1918 and commenced manufacture of this shoe and other specialties, with a staff of three employees, contrasting with more than 1400 employees today.

With the advent of the Signal Hill and Santa Fe Springs fields, the general offices were moved to Huntington Park where a modern factory was built in 1922. The number of employees at that time numbered 12.

In 1936 an office building and plant were built at Houston, followed by occupancy of the present Los Angeles plant and general offices in 1950. Baker Oil Tools, Inc. now has 60 branch warehouses in the United States, with a wholly owned subsidiary, Baker Transworld, Inc., serving Canada and Venezuela.

T. Sutter, the new president, entered employ of the company in 1922, and was appointed secretary-treasurer and assistant general manager in 1923. He became executive vice president and general manager in 1930, and thereafter held both offices until election as president and general manager on April 10, 1957.

Sutter is a past president of Petroleum Equipment Suppliers Association; one of the founders, and the second president of the Los Angeles Chapter of Nomads. He is currently a member of the executive committee of the Merchants & Manufacturers Association, Los Angeles; a vice president of Metal Trades Association of Southern California; and a senior member of the Petroleum Production Pioneers, having served for many years as its first historian.

Full engineering details show . . .

How to Design

A Closed Rotative Gas Lift System

Procedures for both continuous and intermittent methods including gas requirements, selection of compressors, volume reservoirs, flow diagrams

H. W. Winkler,
Camco, Incorporated, Houston, Texas

A closed rotative gas lift system permits the artificial lifting of many wells with a central power supply. It is referred to as "closed" because the injection gas is recycled. High pressure gas from the compressor is injected into wells to lift the fluids. Injection gas and produced fluids pass to the separator where the liquid phase is removed. Gas returns to the compressor where it is recompressed, thus completing the cycle.

By properly designing the low and high-pressure systems, no make-up gas from an outside source is needed for most installations once placed in operation. Fuel required to drive prime movers for the compressors is obtained from the produced formation gas.

The closed rotative system offers maximum flexibility with minimum per well cost. Economic advantage increases with the number of wells and increased depth of lift. Higher gas costs and strict conservation measures are making it more attractive. Rotative gas lift systems can be designed to sell high pressure gas at a premium when excessive formation gas is being produced.

Suggested procedures for designing a closed rotative gas lift system are outlined in following sequence:

1. Gas requirements and injection pressures.
2. Gas lift by continuous flow.
3. Intermittent gas lift operation.
4. High pressure injection gas system.
5. Low pressure gas gathering system.
6. Compressor selection.
7. Flow diagram and gas regulation of typical closed rotative gas lift system.
8. Considerations for efficient operations.
9. Example calculations for closed rotative system.

Based on a paper by the author and presented at the Fourth West Texas Oil Lifting Short Course, held at Lubbock, Texas, April 11-12, 1957, and sponsored by the petroleum industry of West Texas in cooperation with the Department of Petroleum Engineering at Texas Technological College at Lubbock.

Gas Requirements and Injection Pressures

Gas requirements can be divided into those at present and at abandonment. Injection pressure selected should be adequate to efficiently gas lift the wells to depletion. Initial compressor sizes can be based on present gas requirements provided the wells' producing characteristics are not rapidly changing.

The producing characteristics at present and at depletion for all the wells to be included in the gas lift system should be tabulated. This should include the present gross daily fluid production and water cut, depth of producing zones, productivity indices, static bottom-hole pressures, and the same data at depletion. These data will generally permit the operator to group all the wells as two or three representative wells. Initial and ultimate gas requirements can be calculated for the representative wells and multiplied by the number of wells in each category.

For intermittent wells with little known data, gas requirements can be based on 300 to 400 cu ft per bbl per 1000 ft of lift.[1] If the well will flow by heads or an efficient chamber installation has been installed, less gas will be required; but wells with emulsion problems, high back pressure, or low injection pressure relative to depth of lift will require more gas. The injection pressure should be approximately 100 psi for each 1000 ft of lift for efficient operation.[2]

A continuous flow gas lift installation requires a detailed analysis for accurate determination of optimum injection pressure, point of gas injection, and gas requirements for minimum compressor horsepower.

These calculations should be based on the maximum fluid production and minimum bottom-hole pressure expected during the productive life of the wells for selecting the injection pressure. Complete analysis is beyond the scope of this paper but it is thoroughly explained in *The Power of Gas* by Professor C. V. Kirkpatrick. Briefly the analysis consists of: (1) Determining the flowing pressure traverses for various injection gas-fluid ratios and tubing back pressures; (2) plotting the required injection pressures vs the injection gas-fluid ratios for the different back pressures assumed in step (1), and (3) calculating and plotting the theoretical, adiabatic horsepower requirements vs the injection pressures for each tubing back pressure considered.

Selection of injection pressure for minimum horsepower

requirements represents the optimum design condition. If a detailed study cannot be justified because of limited well data, gas estimates for continuous flow can be based on 200 cu ft per bbl per 1000 ft of lift for nominal tubing back pressures.[3]

For injection gas-fluid ratios less than 200 cu ft per bbl per 1000 ft of lift, an injected pressure in psig should be equal to, or greater than, the required depth of gas injection divided by 5. This point of gas injection should not be confused with the total depth of the well, but represents the point at which the injected gas must enter the fluid column to provide sufficient aeration to obtain the flowing bottom-hole pressure for a desired rate of production. For a point of gas injection at 3000 ft, the injection pressure should be approximately 600 psig for wellhead tubing pressures of 30 to 60 psig. Injection pressure should be greater for higher tubing back pressures.

Injection gas requirements represent the cubic feet of gas needed per day to lift the wells. If all wells in the system can be produced to depletion by continuous flow, compressor sizing is no problem. Injection gas is supplied to the wells at a constant rate. Intermitting wells which can be produced most efficiently with a time cycle surface controller create a fluctuating demand for injection gas. Large volumes of injection gas are required over short intervals of time, and between injections no gas is required.

Gas Lift by Continuous Flow

Design of the high-pressure gas injection and low-pressure gathering systems represents no problem if all wells are being continuously flowed. Gas is injected and produced at a relatively constant rate; therefore, compressor sizing can be based on daily gas requirements without considering storage. Injection gas volume can be controlled by a choke, pressure regulator or metering valve.

In some areas, freezing may occur. If dehydration equipment is not effective or injection of small quantities of alcohol does not prevent freezing, full open or closed type diaphragm valves can be used on the injection gas line. Diaphragm valve is operated by a snap-acting pressure or time cycle pilot which results in interrupted gas injection to prevent solid hydrates from forming. Injection lines should be checked for pressure loss which will normally be negligible for average continuous flow gas requirements in 2-in. or larger lines. Continuous flowing wells are in the minority of gas lift installations and represent little difficulty in the design of the closed rotative system.

Intermitting Gas Lift Operation

High pressure gas should be injected into the tubing through the valve at a rate which will insure no pressure drop under the liquid slug until this slug has surfaced. Field tests indicate that the liquid slug should have an average velocity of at least 800 to 1000 ft per min for minimum fall-back and maximum recovery per cycle. Fig. 1 is a 24-hr rotation 2-pen pressure recording chart of the tubing and casing pressures of an actual 5200-ft depth well in which the operating intermitting valve is located at 5000 ft.

A 24-min chart of the tubing and casing pressures is shown in Fig. 2. This well is being efficiently intermitted. Injection pressure represents approximately 100 psi per 1000 ft of depth. An adequate volume of gas is being introduced under the liquid slug to provide an average velocity of over 900 ft per min.

Figs. 3 and 4 are 24-min rotation 2-pen tubing and casing pressure recording charts of an intermitting well with the operating gas lift valve at 4500 ft. The duration of gas injection was increased from 35 sec in Fig. 3, to 55 sec in Fig. 4, and the average slug velocity increased from 400 to 800 ft per min. Production increased from 1.3 bbl to 2 bbl per cycle. The bottom-hole pressure recording obtained simultaneously with Figs. 3 and 4 shows that the starting fluid heads were about the same. Greater recovery and increased drawdown

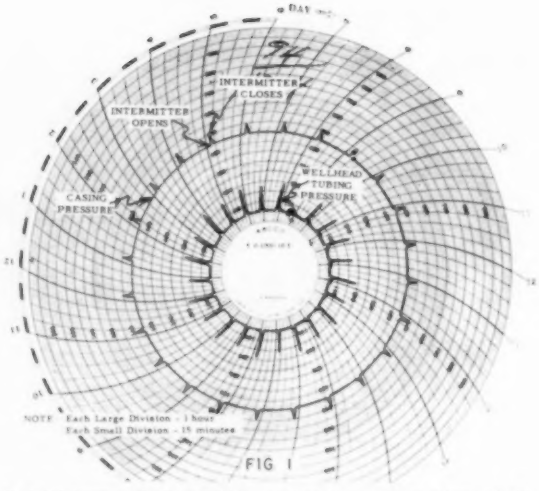


FIG. 1. **24-hour rotation tubing** and casing pressure chart of efficiently intermitting well with 5/16-in. port valve at 5000 ft.

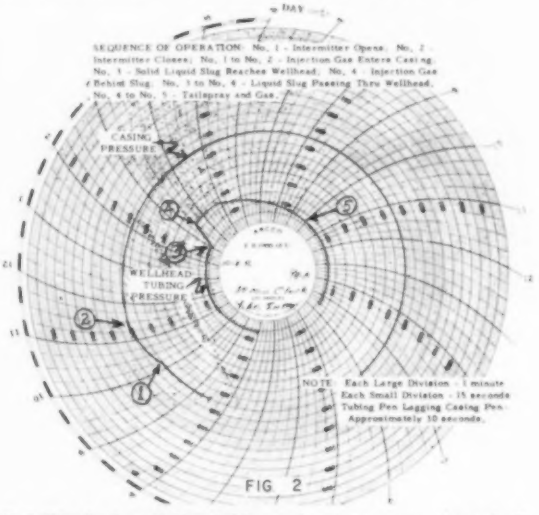

DAY
SEQUENCE OF OPERATION: No. 1 - Intermitter Opens. No. 2 - Intermitter Closes. No. 1 to No. 2 - Injection Gas Enters Casing. No. 3 - Solid Liquid Slug Reaches Wellhead. No. 4 - Injection Gas Behind Slug. No. 3 to No. 4 - Liquid Slug Passing Thru Wellhead. No. 4 to No. 5 - Tailspray and Gas.
CASING PRESSURE
WELLHEAD TUBING PRESSURE
NOTE Each Large Division - 1 minute
Each Small Division - 15 seconds
Tubing Pen Lagging Casing Pen Approximately 30 seconds.
FIG 2

FIG. 2. **24-minute rotation tubing** and casing pressure chart of efficiently intermitting well with 5/16-in. port valve at 5000 ft.

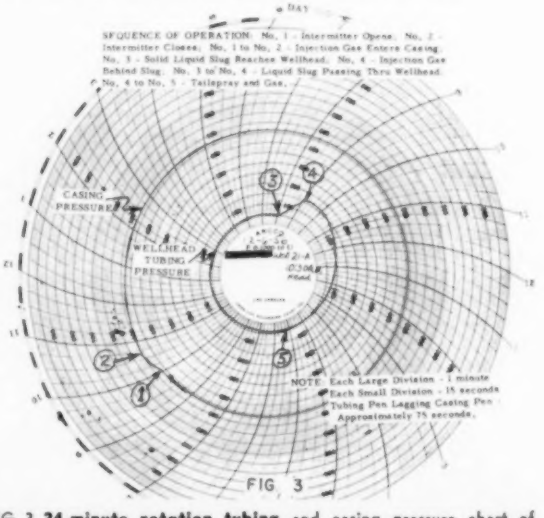

DAY
SEQUENCE OF OPERATION: No. 1 - Intermitter Opens. No. 2 - Intermitter Closes. No. 1 to No. 2 - Injection Gas Enters Casing. No. 3 - Solid Liquid Slug Reaches Wellhead. No. 4 - Injection Gas Behind Slug. No. 3 to No. 4 - Liquid Slug Passing Thru Wellhead. No. 4 to No. 5 - Tailspray and Gas.
CASING PRESSURE
WELLHEAD TUBING PRESSURE
NOTE Each Large Division - 1 minute
Each Small Division - 15 seconds
Tubing Pen Lagging Casing Pen Approximately 75 seconds.
FIG 3

FIG. 3. **24-minute rotation tubing** and casing pressure chart of inefficiently intermitting well with 3/8-in. port valve at 4500 ft.

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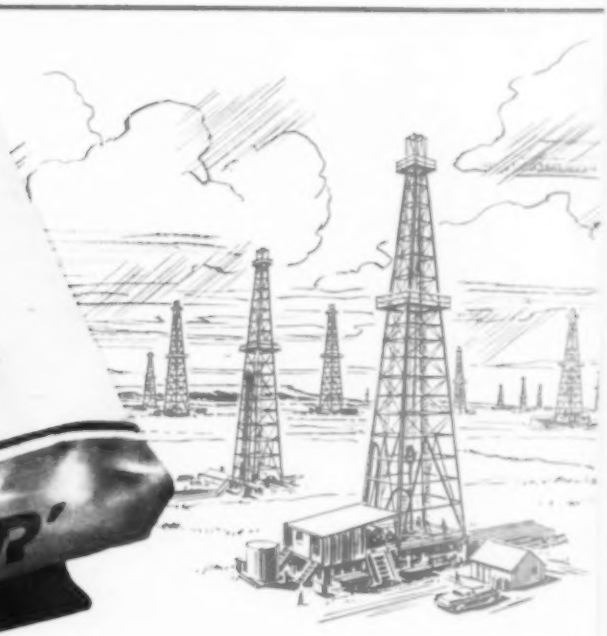

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result from less fall-back with a slug velocity of 800 ft per min.

Injection gas plus produced gas returns to the system at a rate much slower than that at which the injection gas is introduced into the well. A 2-hr rotation chart for injection and produced gas is shown in Fig. 5. This total gas-out chart is from the same well as Figs. 1 and 2. There is approximately 2500 ft of 2-in. flow line between the well and tank battery. Chart shows gas entering the low-pressure system at a maximum rate of 420 cu ft per min for less than a minute with an average rate of over 260 cu ft per min for approximately 4 min. The remaining gas enters the system before and after the main head at a rate of less than 60 or 70 cu ft per min.

If the compressor station were capable of compressing 420 cu ft per min, no gas would be vented regardless of the capacity of the low pressure system. If 2 or more wells should intermit at the same time, gas would be vented unless adequate storage had been designed in the gas gathering system. Normally, for each cycle, the bulk of injection and produced gas takes over 4 min to enter the system for typical operating conditions as illustrated in Figs. 1, 2, and 5. Volume of the low pressure system should be based on the peak rate of total gas-out per cycle. This rate can be estimated by dividing the total gas-out in cubic feet per cycle by a factor of at least 4. Long and/or small flow lines, large casing annulus volumes, increased depth of lift, and high injection pressures result in a larger factor. For example, in Fig. 5 the total gas-out is 2600 cu ft per cycle and the peak rate is 420 cu ft per min. This represents a factor of 6.2.

High Pressure Injection Gas System

Adequate volume in the high-pressure injection gas system is necessary to decrease compressor requirements for leases with intermitting gas lift wells using time cycle surface controllers. This high-pressure storage provides the difference in gas volume between the compressor output and instantaneous intermitting gas requirements to efficiently lift the wells. Ample volume of high pressure gas stored in this system permits the selection of a compressor size that delivers the gas lift requirements over a 24-hr period rather than on a per minute basis.

When several wells in the same system must be intermitted and maximum cycle rates are required to obtain production, volume of gas in the high-pressure system must be adequate to permit more than one well to inject gas at the same time. The number of wells which could intermit at one time must be estimated for each closed rotative system. The greater the number of injection cycles per day, the greater the number of wells which could intermit at the same time. Staggering the wells can be assured only if one central timer is used to actuate the individual surface controllers at the various wells.

Example. Assume that a well requires 1000 cu ft per min for efficient lifting, but the compressor delivers only 500 cu ft per min. Storage must supply the additional 500 cu ft per min. If no storage existed, the compressor must be capable of delivering 1000 cu ft per min.[4] Since storage can be obtained for less cost than the additional compressor horsepower, adequate storage should be incorporated in rotative gas lift systems. The smaller the system, the more critical this volume becomes.

Gas volume available for injection in the high-pressure system is primarily a function of the actual pipe capacity of the system and the difference in pressure between the operating injection pressure at the well and the pressure maintained in the system by compressors. If the pressure in the system and operating injection pressure were the same, the per minute gas requirements available to the wells would be only the output of the compressor. The actual cubic feet of gas stored in the high-pressure system can be calculated with the following equation:

$$V_s = \left[\frac{P_h}{Z_h} - \frac{P_i}{Z_i}\right] \frac{V_h T_s}{P_s T_h} \quad . \quad . \quad . \quad . \quad (1)$$

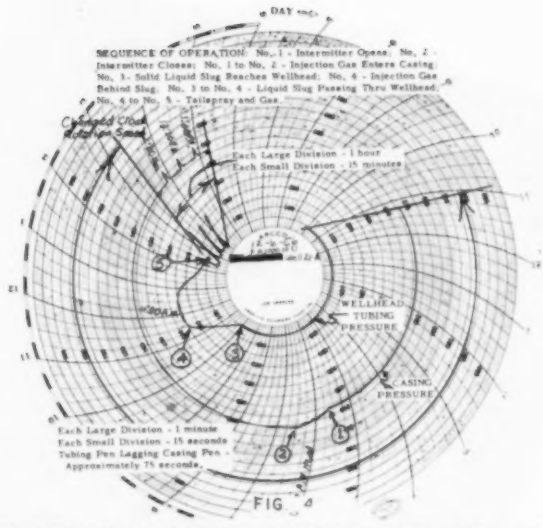
SEQUENCE OF OPERATION: No. 1 - Intermitter Opens. No. 2 - Intermitter Closes. No. 1 to No. 2 - Injection Gas Enters Casing. No. 3 - Solid Liquid Slug Reaches Wellhead. No. 4 - Injection Gas Behind Slug. No. 3 to No. 4 - Liquid Slug Passing Thru Wellhead. No. 4 to No. 5 - Tailspray and Gas
Each Large Division - 1 hour
Each Small Division - 15 minutes
WELLHEAD TUBING PRESSURE
CASING PRESSURE
Each Large Division - 1 minute
Each Small Division - 15 seconds
Tubing Pen Lagging Casing Pen - Approximately 75 seconds.
FIG 4

FIG. 4. **Combination 24-minute and 24-hour** rotation tubing and casing pressure chart of efficiently intermitting well with 3/8-in. port valve at 5000 ft.

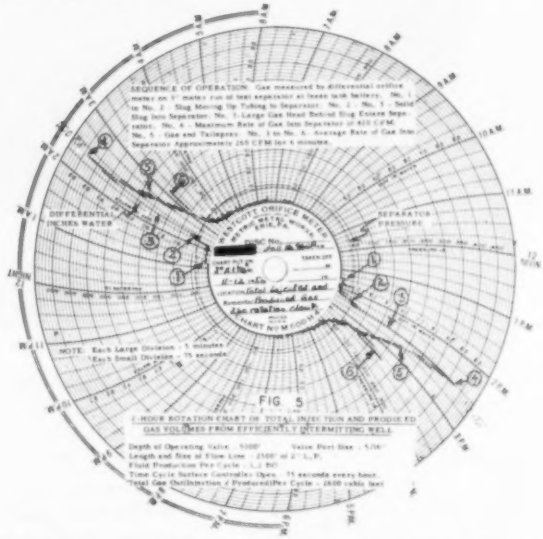

FIG. 5. **Two-hour rotation chart** of total injection and produced gas volume from efficiently intermitting well with 5/16-in. port valve at 5000 ft.

Where:

P_h = Pressure in the high-pressure system, psia.
P_i = Injection pressure at wellhead, psia.
P_s = Standard pressure base, psia.
T_h = Temperature of gas in high-pressure system, °R.
T_s = Standard absolute temperature base, °R.
V_h = Capacity of high-pressure system, cu ft.
V_s = Volume of gas stored in system at standard conditions, cu ft.
Z_h = Compressibility factor at P_h and T_h.
Z_i = Compressibility factor at P_i and T_h.

The compressibility factor was included in Equation (1) to permit accurate gas volume calculations of the high-pressure system. These compressibility factors can be found in the Natural Gasoline Supply Men's Association (NGSMA) Engineering Data Book, *The Power of Gas*, and other publications dealing with gas calculations. However, for preliminary design estimates, compressibility factors can be neglected,

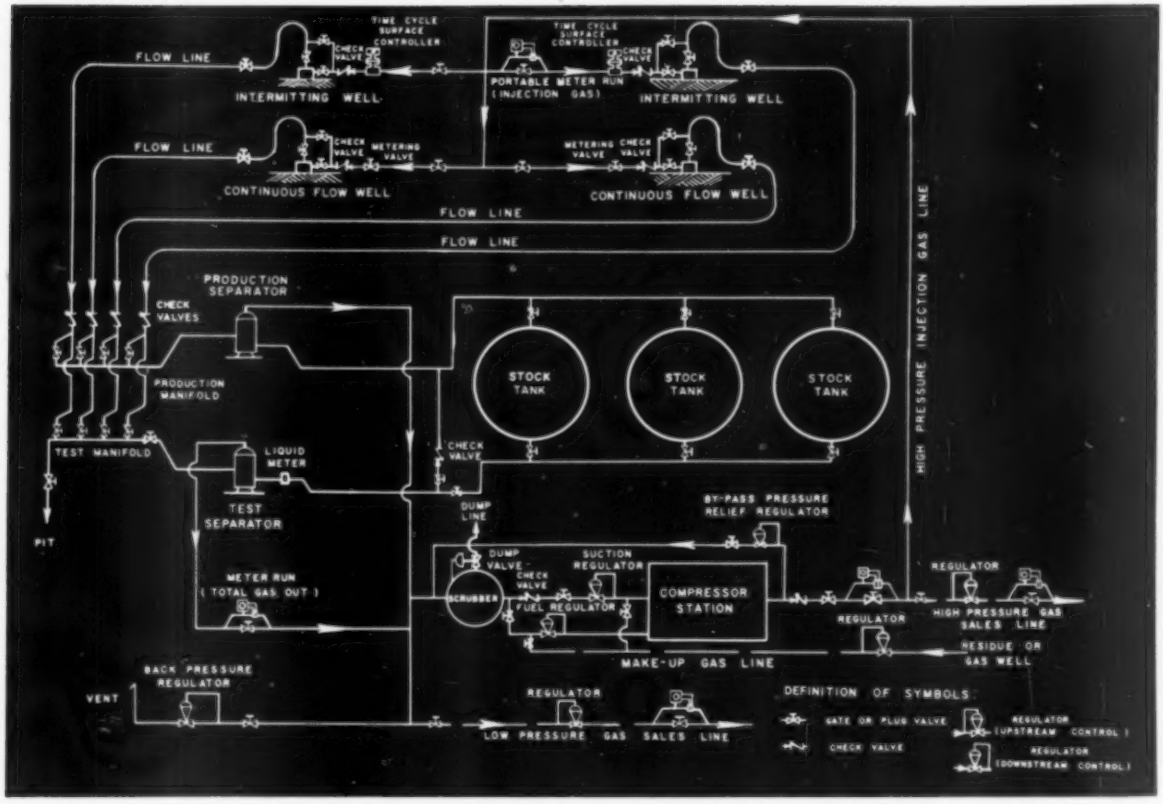

FIG. 6. **Closed rotative gas lift system** including all principal equipment and regulators and check valves.

and the equation given for a low-pressure system can be employed.

Pressure losses in lines. After designing sufficient volume into the system to provide the difference between the compressor output and the per minute demand for the intermitting wells, gas lines should be checked for excessive pressure loss. Pressure losses for intermitting wells should be based on a rate equivalent to the per minute injection gas requirements to efficiently lift the wells. Weymouth's formula is the most widely used equation for determining the pressure loss in gas lines.

Weymouth's formula is generally expressed in a form which will give the rate of flow through a pipe of known internal diameter and length when the inlet and terminal pressures are given. The pressure loss in a line for a given rate of flow and upstream pressure is required for the proper design of the high and low-pressure systems. These determinations can be made by using an alignment chart for the solution of Weymouth's formula and working the problem in reverse. These alignment charts are available in many publications such as the NGSMA's Engineering Data Book. Weymouth's formula can be expressed in terms of pressure loss in a line as follows:

$$\Delta p = 0.000504 \left(\frac{P_s}{T_s}\right)^2 \left[\frac{(Q_s)^2 L G T}{P_m (d)^{5.333}}\right] \quad . \quad . \quad (2)$$

Where:

d = Internal diameter of pipe, in.
Δp = Pressure loss in pipeline, psi.
G = Gas gravity of flowing gas (air = 1.0).
L = Length of line, ft.
P_m = Mean pressure in line which is equal to initial pressure plus terminal pressure divided by 2, psia.
P_s = Standard pressure base, psia.
Q_s = Rate of gas flow in 1000 cu ft per day at standard conditions, Mcfd.
T_s = Standard absolute temperature base, °R.
T = Absolute temperature of flowing gas, °R.

For standard conditions of 14.65 psia and 60 F (520 R), gas gravity of 0.6 and gas flowing temperature of 60 F (520 °R), the equation can be simplified as follows:

$$\Delta p = 0.000125 \left[\frac{(Q_s)^2 L}{P_m (d)^{5.333}}\right]$$

The exact pressure loss can be calculated by trial and error, assuming a mean pressure in the line for each attempt. The alignment chart for the solution of Weymouth's formula is less laborious than the above equations. The difference in initial and terminal pressures squared is obtained from the chart and the terminal pressure can be calculated from this difference for a known initial pressure.

The following tabulation is useful in calculating volumes and pressure losses in both high and low-pressure systems:

TABLE 1. API Line Pipe Data.

Size (in.)	I. D. (in.)	Cu Ft per 1000 ft	$(d)^{5.333}$
2	2.067	23.30	48.1
2½	2.469	33.25	124.0
3	3.068	51.34	395.1
4	4.026	88.40	1682.5
6	6.065	200.63	14,965.0

Low Pressure Gas Gathering System

The low-pressure system should provide adequate storage of gas to prevent starving compressors between intermissions and prevent venting gas if more than one well intermits at the same time. Volume of the suction reservoir includes the low-pressure system between flow line check valves and the suc-

tion regulator at the compressor station. Since check valves are generally installed in the flow lines near the tank battery, flow lines between wells and checks should not be considered part of the suction volume. The separator and the make-up gas line, low pressure sales line, and the vent line between the separator and the regulators all become part of the low-pressure suction volume.

Regulators and check valves. No check valves or pressure regulators should be installed between the separator and suction of the compressor except the suction regulator at the compressor station. If low pressure gas is being sold or piped away for other uses, the pressure regulator should be located as far away as possible from the compressor station. This increases the volume in the low-pressure system.

The same consideration should be given to the location of the make-up gas regulator. If gas is being taken from a low-pressure gas well, the regulator should be near the well and not the battery in order that the flow line can be included in the low pressure system. If make-up gas is obtained from a residue line, the regulator and checks should be as far from the station as possible for the same reason. Suction volume can be increased by using abandoned wells.

Storage gas volume. Gas volume which can be stored in the low-pressure system, like the high-pressure system, is a function of pressure difference and pipe capacity. This pressure difference is the separator pressure less the suction pressure, and these pressures are controlled as shown in the flow diagram in Fig. 6. For a given suction pressure, the volume of gas in the low-pressure system increases proportionally with an increase in separator pressure. As a general rule, intermitting gas lift wells can be produced against higher separator pressures than wells being gas lifted by continuous flow without significantly increasing the injection gas requirements. A closed rotative system consisting of intermitting wells can be designed to take advantage of the higher separator pressure in order to increase the gas volume of the low-pressure system.

The compressibility factor is neglected in the following equation for calculating gas volumes in the low pressure system:

$$V_s = (P_L - P_1)\left[\frac{V_L T_s}{P_s T_L}\right] \quad . \quad . \quad . \quad . \quad (3)$$

Where:

P_L = Pressure in low-pressure system, psia.
T_L = Temperature of gas in low pressure system, °R.
V_L = Capacity of low-pressure system, cu ft.
P_1, T_s, and V_s = previously defined under Equation (1).

The importance of adequately sizing the low-pressure system for intermitting wells cannot be overemphasized where make-up gas is costly or not readily available. When gas from intermitting wells reaches the surface, it will be vented or sold through a low-pressure sales line if the system is undersized. Once this gas has left the system, it cannot be recycled for lifting purposes. For this reason, systems which include mostly low formation gas-oil ratio wells must have ample low-pressure storage. Systems with high gas-oil ratio wells will work satisfactorily with smaller storage because excess gas is being produced from the wells.

Compressor Selection

Detailed sizing of compressors should be left to compressor manufacturers because of its complexity. The following information will assist the compressor manufacturer to propose the most suitable unit or units:

1. Total gas requirements per day, hour, or minute at a specific temperature and pressure base.
2. Suction and discharge pressures clearly stated in psig or psia.
3. Atmospheric pressure at station site.
4. The N value (ratio of specific heats — C_p/C_v) of gas and/or gas gravity. The N value of the gas can be approximated from the gas gravity.
5. Preference for integral or belt driven compressors and size of units. If compressor is to be driven by prime

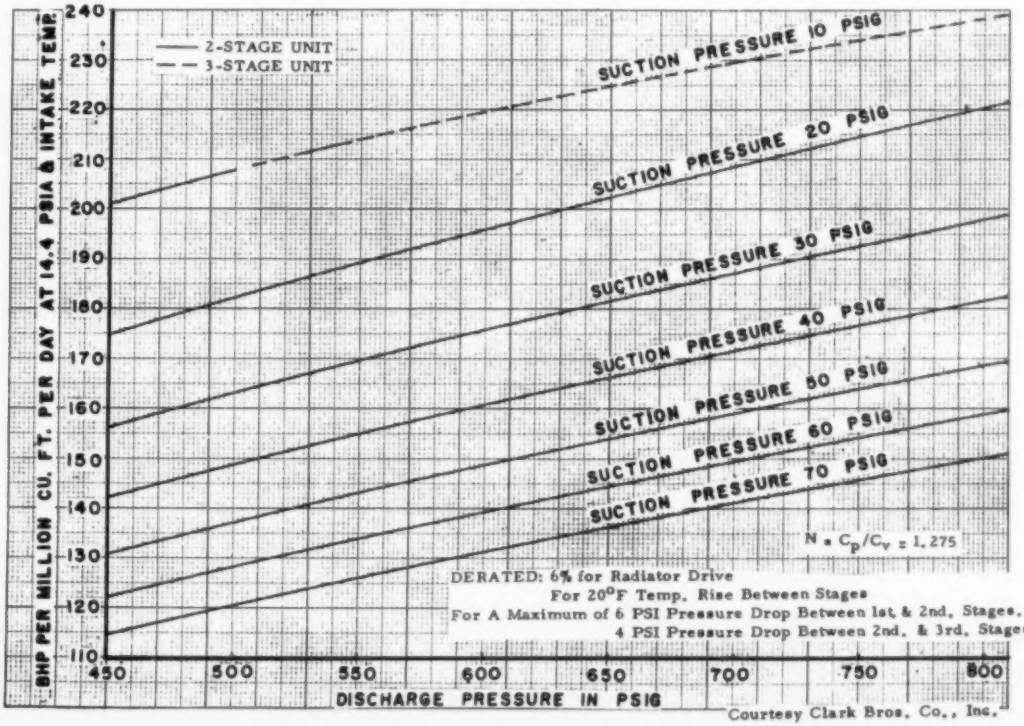

FIG. 7. **Approximate compressor brake horsepower** per million cubic feet per day at 14.4 psia and inlet temperature for suction pressures from 10 to 70 psig and discharge pressures from 450 to 800 psig.

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FIG. 8. **Skid-mounted belt-driven packaged compressors** used for gas lifting wells in small rotative system.

mover other than a gas engine, this should be noted.

6. Temperature of inlet gas (suction temperature) and outlet gas (discharge temperature) at the compressor. Availability of water for cooling.

The brake horsepower of a compressor varies with the compression ratio. The approximate brake horsepower required to compress 1,000,000 cu ft per day at 14.4 psia and suction temperature is given in Fig. 7. For example, to compress one MMcfd of gas from 30 psig to 600 psig represents a compression ratio of 13.8 and requires approximately 176 bhp. A compression ratio of only 8.2 is needed to compress gas from 60 psig to 600 psig and the horsepower requirements are approximately 139 bhp per MMcfd.

Although a high suction pressure requires less compressor horsepower for the same discharge pressure and gas volume, this does not necessarily mean an overall savings in compressor cost in a gas lift installation. The injection gas-fluid ratio increases with the tubing back pressure. An example of suction pressure vs compressor horsepower requirements is shown in the following tabulation which was prepared for a 9-well, closed, rotative gas lift system in Louisiana. Depth of wells is 8000 ft and the estimated total fluid production from all 9 wells is 3100 BFPD.[5]

Compressor		Total Injection	
Discharge psig	Suction psig	Gas Mcfd	Cost Compressor
800	40	932	$22,600
800	100	1592	48,000
800	200	3269	54,000

Final selection of smaller units vs a large unit or units and belt driven vs integral compressor is dependent on many factors which vary from installation to installation. Smaller units have many advantages. Initial investment is lower provided initial gas requirements are less than ultimate and the compressor station is designed for present needs. A station with several small compressors permits the repair of a single unit with little or no loss of production.

A majority of small rotative gas lift systems use skid-mounted belt-driven compressors as shown in Fig. 8 because the smaller units cost considerably less than the integral compressors. This difference in cost increases as the brake horsepower decreases. Skid-mounted units can be transferred from lease to lease for testing as well as for use as permanent installations. Problems associated with belt-driven units have been minimized by using heavy mounting skids, and the belt losses represent approximately 5 percent of the compressor horsepower. The largest belt-driven package compressor presently available is around 300 bhp.

Larger compressor stations as shown in Fig. 9 generally consist of integral compressors because they are more heavily constructed, more rugged units which require less detailed attention and maintenance. Their longer life and lower maintenance costs result from a low speed prime mover instead of a higher speed automotive type engine, heavier frame load allowables, elimination of sheaves, jack shafts with bearings, coupling or clutch, and belts. In larger size compressors where it would require two or more belt driven units for one integral type compressor, the integral compressor becomes competitive in cost with the belt driven unit.

Fuel consumption of both the belt driven and angle type compressor is comparable when both types of prime movers are operating properly. Fuel consumption in cubic feet per day can be estimated by multiplying the compressor horsepower by 240.[6] This figure represents approximately 10 cu ft per bhp-hr of a 900 to 1000 BTU gas.

FLOW DIAGRAM AND GAS REGULATION OF A CLOSED ROTATIVE GAS LIFT SYSTEM

A flow diagram of a closed rotative gas lift system is shown in Fig. 6. This diagram must be altered to meet requirements for individual installations, and may include dehydration equipment, a simple or elaborate distillate recovery plant, etc.

Regulator selection and location are extremely important for efficient operation of the system. The suction pressure regulator prevents compressor overloading and stalling. This regulator is set lower than maximum pressure in the low-pressure system which is controlled by the back pressure regulator on the vent or gas sales line. If a low-pressure gas sales outlet is available, this regulator will control the volume of gas which can be stored in the low-pressure system by providing a pressure difference between suction pressure and separator pressure. The regulator on the vent is used as a relief valve and is set higher than the sales regulator.

Make-up gas regulator is set to open at a pressure slightly below the set pressure of the suction regulator. Make-up gas line should be connected into the suction line between the suction regulator and compressors.

By-pass pressure regulator at the compressor should be set to open at a higher pressure than the regulator on the high-pressure gas sales line. Both regulators are employed to prevent excessive pressure build-up on the high-pressure system.

A variation in pressure regulation of the low-pressure system is used in some compressor installations where surplus produced gas is always entering the system. This excess gas is generally supplied by flowing wells. Suction pressure of the compressor is controlled by either the back pressure regulator on the vent or low-pressure gas sales line if there is a sales line. The suction regulator at the compressor is eliminated, and there is no storage in the low-pressure system. Gas available for compressing at suction pressure is only the volume entering the system, and there is no surplus in case excess gas is temporarily cut-off.

Considerations for Efficient Operation

Rated discharge pressure of a compressor should be 100 to 200 psi above the expected operating gas lift pressure. This additional pressure provides gas storage in the high-pressure system and permits using higher opening pressure gas lift valves for unloading to the operating valve.

A choke can be used in conjunction with the time cycle surface controller to lengthen the injection time for intermitting wells. The choke must pass more gas than the operating

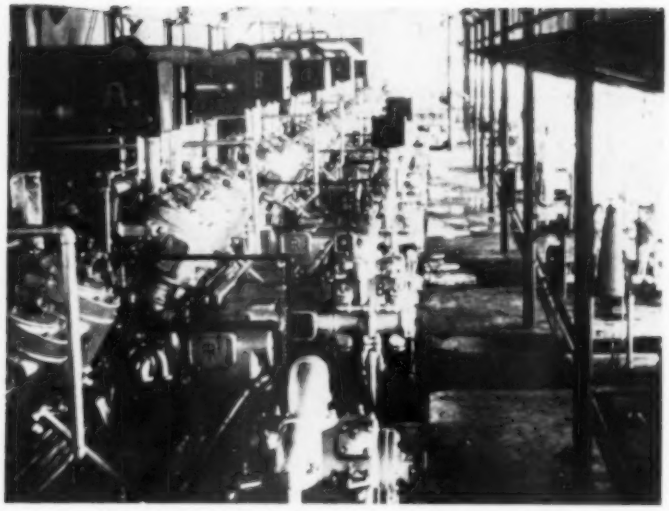

FIG. 9. **Integral angle-type compressors** for gas lifting an entire field with a single large compressor station.

valve to assure efficient lifting of the liquid slug. Increasing injection time from 1 min to 2 min with a choke would reduce the per minute injection gas requirements by one-half.

Separators of nearby batteries with flowing wells should be tied into the low-pressure gathering system when possible, to provide adequate compressor suction volume. Additional gas and storage volume can be obtained from the casing annulus of pumping wells by connecting the casing outlets into the gathering system. If a high-pressure gas line is near the compressor station, the station can be partially justified and paid-out by the sale of high-pressure gas.

Injection gas lines, suction lines, and flow lines selected should provide sufficient capacity for depletion of the wells. Initial laying of a large line will generally be less expensive than looping or paralleling smaller lines at a later date. This is particularly true of wells with buried lines and high water cuts at abandonment.

Automatic dump valves should be located in the suction and interstage scrubbers of the compressors. These traps should have magneto or fuel line shut-down devices in case dump valves fail.

In many instances, a pulsating condition in the high-pressure system results in poor metering of the compressor discharge gas. A large choke which causes little pressure loss will generally eliminate severe pulsations.

In a rotative system where make-up gas is scarce, wells should be closed-in during a compressor station shut down to prevent venting gas after the low-pressure gathering system has filled.

Calculations for a Closed Rotative System

It is proposed to build a closed rotative gas lift installation on a lease which is producing from two formations. Four wells are producing from a depletion type reservoir and 4 wells from a reservoir which has an active water drive. Wells in the depletion type reservoir are being lifted at present with gas from a nearby gas well which is near depletion. These intermitting wells have low productivity indices between 0.02 and 0.04 bbl per psi drawdown. Chambers will be installed to deplete the reservoir at a later date.

Flowing wells will gradually go to water and the predicted water-oil ratio at abandonment is 19:1. The static bottom-hole pressure at abandonment will be approximately 1650 psig. A waterflood project is planned to maintain this pressure later in the life of the reservoir.

The compressor station will be designed to meet present requirements for 4 wells with gas lift equipment and will be increased as additional wells are added. Injection lines, flow lines, and gathering lines will follow lease roads as shown in Figs. 10 and 11. The compressor site will be centrally located near the entrance to the lease. Initial installation will include adapting present injection lines for intermitting wells. The remaining injection lines will be installed as additional wells go on lift. Large suction lines are proposed between two 4-well batteries and the compressor station to provide adequate storage in the low-pressure system for the intermitting wells.

Average current well data and estimated gas lift requirements for the intermitting wells (Producing Zone A):

Number of wells — 4
Total depth — 5200 ft
Casing size — 5½-in. OD
Tubing size — 2-in. EUE
Depth of operating valve — 5000 ft
Producing rate — 30 BOPD
Percent water — Trace
Producing GOR — 800:1
Injection GFR — 1600:1
Injection cycle — 1 min every hr

Average current well data for the presently flowing wells (Producing Zone B):

Number of wells — 4
Total depth — 5400 ft
Casing size — 5½-in. OD
Tubing size — 2-in EUE
Producing rate — flowing 50 BOPD
Percent water — None
Producing GOR — 500:1
Productivity index — 4
Static bhp — 2200 psig

A tabulation of the estimated gas requirements for present and future are as follows:

TABULATION 1. Present and Depletion Estimated Gas Lift Data Per Well.

	PRESENT			
	Production		Inj.	Point
	Oil	Water	Gas	of Inj.
Well	(BOPD)	(BWPD)	(Mcfd)	(Ft)
Zone A	30	Trace	50	5000
Zone B	50	None	None	——
	DEPLETION			
Zone A	5	Trace	10	5000
Zone B	30	570	240*	2500

*Zone B injection gas requirements at abandonment are based on an injection gas-fluid ratio of 400 cu ft per bbl of fluid lifted. The required injection gas-fluid ratio was calculated for a surface injection pressure of 500 psig by the method outlined in *The Power of Gas*.

TABULATION 2. Total Injection Gas Requirements.

		Gas Requirements	
	No.	Present	Ultimate
Well	Wells	(Mcfd)	(Mcfd)
Zone A	4	200	40
Zone B	4	0	960
Total Requirements		200	1000

After determining gas requirements, the compressor station should be sized for both present and ultimate requirements. Careful consideration should be given to sizing individual units to avoid having a number of small units at time of depletion. An excessive number of small units increases the detailed attention and maintenance and results in a higher final total cost of the station. In this example, the following additional data are used to select the compressors:

Suction pressure — 30 psig
Low-pressure sales regulator — 60 psig
Discharge pressure — 650 psig
Injection gas gravity — 0.6

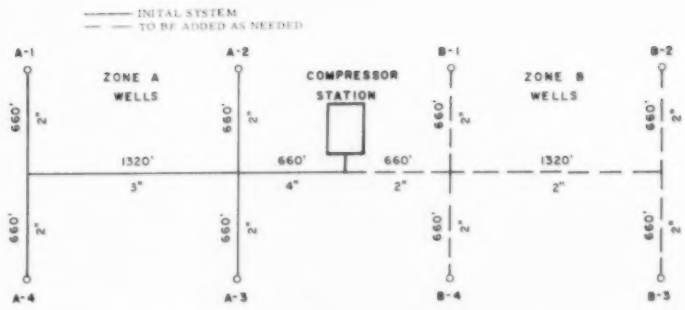

FIG. 10. **Initial and ultimate** high pressure injection gas system for lifting 8 wells on 40-acre spacing.

Injection pressure for gas lifting — 500 psig
Flowing gas temperature in low and high-pressure systems — 100 F
Pressure and temperature base — 14.7 psia and 60 F.

Proposed compressor sizing, present and future:

From Fig. 7 for 30 psig suction and 650 psig discharge:
Approx hp = 182 bhp/MMcfd at 14.4 psia and 100 F
= 200 bhp/MMcfd at 14.7 psia and 60 F
For present requirements of 200Mcfd at 14.7 psia and 60 F:
Approx hp = 40 bhp
For ultimate requirements of 1000 Mcfd at 14.7 psia and 60 F:
Approx hp = 200 bhp

Since initial gas requirements represent only 20 percent of the ultimate and too many small units are undesirable, it is proposed to set one 80 bhp compressor at this time and add two more 80 bhp packaged units as needed. These compressors should provide adequate capacity to permit servicing or repair of a single unit with little or no loss in production during the final stage of gas lifting, when the gas requirements are at a maximum.

Volume of high-pressure system. Volume of the high-pressure system must be adequate for present and ultimate stages of gas lift. The present gas lift program represents the major problem because the first 4 wells must be intermitted. Input gas required to efficiently lift the wells is 2000 cu ft of gas per min from well data given. Proposed injection lines are shown in Fig. 10 and represent a present capacity of 191 cu ft. Using Equation (1), maximum volume of gas which can be stored in the system is:

$$V_s = \left[\frac{664.7}{0.915} - \frac{514.7}{0.935} \right] \frac{191(520)}{14.7(560)} = 2120 \text{ cu ft}$$

In actual practice, it is better to design the high-pressure system for intermitting wells with sufficient storage to supply the total gas requirements for one complete injection cycle from storage only. Output of the compressor is purposely neglected in case actual gas requirements should be higher than those which were estimated.

Since high-pressure gas will be injected into each well approximately 1 min every hr, it will be assumed that the injections can be staggered. The 80 bhp compressor has a rated output of 278 cu ft per min at 650 psig; therefore, the 2000 cu ft required per injection will be replaced in the system in approximately 7 min. Little difficulty with interference between wells should be encountered because it is possible to have 14 min between gas injections if the intermitters are properly synchronized.

The injection system will be increased with 4620 ft of 2-in. line to the continuous flow wells by the time the intermitting wells are being lifted by chamber installations. This represents an additional 1200 cu ft of injection gas volume at 650 psig. The additional volume will assure ample injection gas to efficiently lift larger liquid slugs from the chambers. Since the producing rate will require only 2 or 3 gas injections per day, interference between injections will present no problem.

Pressure Losses in High Pressure System

The maximum pressure loss in the intermitting well system will occur through the 660 ft of 2-in. feeder line between the 3-in. trunk line and the well. The 2000 cu ft per min represents 3170 Mcfd at 14.4 psia and 100 F. Using Weymouth's

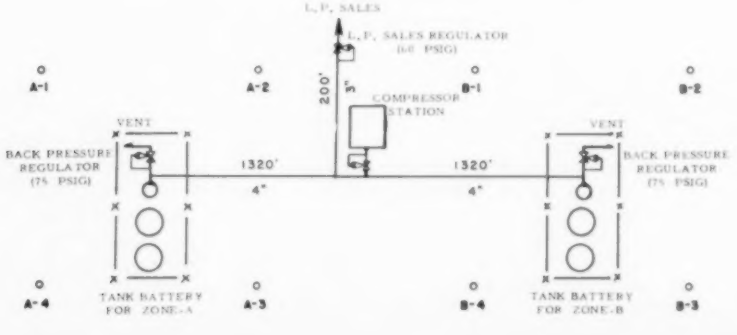

FIG. 11. **Low pressure gas gathering system** for 8-well installation shown in Fig. 10.

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The Author

Herald W. Winkler is assistant chief engineer in charge of gas lift for Camco, Incorporated, Houston, Texas, a position he has held since 1954. Under the sponsorship of Camco, Winkler conducts schools on gas lift for personnel of producing companies in the U.S. and South America. At present he is completing work on an M.S. degree in petroleum engineering at the University of Houston. He is a registered professional engineer and a member of AIME. After graduation from Southern Methodist University with a degree in mechanical engineering, he was employed by The Atlantic Refining Company in West Texas as a production engineer from 1948 to 1952. He joined Camco Gas Lift Company of Odessa in 1952, as a sales engineer and representative in Hobbs, New Mexico, and later in Abilene, Texas.

alignment chart and a mean inlet pressure of 575 psig, (650 + 500)/2, the pressure loss is only 31 psi; therefore, the line sizes are adequate for injection pressure build-up at the well.

Maximum pressure loss in the continuous flow wells' system will be in the first 660 ft of 2-in. line downstream of the compressor because injection gas for all 4 wells must pass through this section. Ultimate daily requirements of 960 Mcfd at 14.7 psia and 60 F is equal to 1055 Mcfd at 14.4 psia and 100 F. From Weymouth's alignment chart, the pressure loss in this 660 ft of 2-in. line is only 4 psi for an average inlet pressure of 575 psig. Two-inch line is proposed for the entire continuous flow system because it is readily available and only slightly higher in cost than 1½ or 1¼-in.

Volume of Low Pressure System

It is proposed to complete the entire gathering system for the initial compressor installation. Fig. 11 shows the lines between two batteries and the compressor station. Capacity of the entire system is approximately 375 cu ft. Using Equation (3) for a suction pressure of 30 psig and a separator pressure of 60 psig, the maximum volume of gas which can be stored in the low-pressure system is:

$$V_s = \frac{30(375)\ 520}{14.7(560)} = 710 \text{ cu ft}$$

The low-pressure system presents no problem in this installation because Zone B wells deliver 100 Mcfd of formation gas into the system. If these wells are produced continuously, 695 cu ft per min of formation gas supplies excess gas for fuel and compression.

Pressure Losses in Low Pressure System

The rated capacity of three 80 bhp compressors is 834 cu ft per min at 14.7 psia and 60 F. Maximum pressure loss would occur if all gas entered the system from one separator. Using Equation (2), the pressure drop through 1320 ft of 4-in. line is only 3 psi for 1200 Mcfd at a flowing temperature of 100 F and a mean separator pressure of 45 psig, (60 + 30)/2.

Excess or Make-up Gas Calculation

Fuel requirements for the initial 80 bhp compressor will be approximately 19,200 cu ft per day. Fuel consumption will increase to approximately 57,600 cu ft per day when all three 80 bhp compressors are in service. Estimated excess formation gas in cubic feet per day for low-pressure sales at present can be calculated as follows:

Formation gas from Zone A =	96,000
Formation gas from Zone B =	100,000
Total produced gas:	196,000
Initial fuel requirements:	— 19,200
Excess produced gas:	176,800

Assuming the gas-oil ratios do not change, excess gas in cubic feet per day at abandonment is:

Formation gas from Zone A =	16,000
Formation gas from Zone B =	60,000
Total produced gas:	76,000
Ultimate fuel requirements:	— 57,600
Excess produced gas:	18,400

Actually, the intermitting wells in Zone A will increase in gas-oil ratio as the reservoir is depleted and will produce more gas than shown above. Gas used for heaters, treaters, pumps, and other lease needs will have to be subtracted from the above figures. Provided excessive gas is not used for lease purposes, this closed rotative system should not require any make-up gas. The system can be filled initially with gas from the Zone B flowing wells. Wells can be gas lifted to depletion with the formation gas supplying the make-up requirements.

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Offshore Operations Highlight API Southern Meet

SHREVEPORT, Louisiana — The new Southern District of API held its biggest meeting last month in Shreveport with 960 oil men attending. Offshore operations took the program spotlight along with election of new officers for the 1957-58 term. Don Connelly, vice president of the Division of Production, made the principal address before the group sessions and reviewed the challenge of the U.S. oil industry. Fourteen API committees met during the first day.

Ben F. Carter

Ben F. Carter, Union Producing Company, Shreveport, was elected chairman, succeeding John M. Payne, Shell Oil Company, Houston. Carter was co-presiding chairman for one of the technical sessions, and was also 1952 vice chairman for Arkansas-North Louisiana for the old Southwestern District. A graduate of Texas A&M College in 1934 in petroleum engineering, he has served continuously with Union Producing with the exception of the war years from 1941-1945. He has served in various field and engineering capacities, and in 1948 was made Eastern Division petroleum engineer, which position he now holds.

Other Southern District API officers elected for the 1957-58 term include: Gore Kemp, B. M. Davis Tool-Machine Company, Kilgore, Texas, vice chairman, East Texas; W. D. Taylor, Schlumberger Well Surveying Corporation, Victoria, vice chairman for South Central Texas; W. W. Bynum, Hycalog, Inc., Shreveport, vice chairman, Ark-La-Tex; J. A. Williams, McCullough Tool Company, Houston, secretary-treasurer; A. T. Pall, The Texas Company, Alice, vice chairman, South West Texas; Fran Yeargers, Schlumberger Well Surveying Corporation, Lafayette, vice chairman, South West Louisiana; Austin Moseley, Southland Drilling Company, San Antonio, vice chairman, Balcones area; Jim Lanston, Humble Oil & Refining Company, Franklin, Louisiana, vice chairman, South Louisiana; H. J. Brady, consultant, McAllen, Texas, vice chairman, Rio Grande Valley; and W. O. Bartle, Brewster-Bartle Drilling Company, Houston, vice chairman, Texas Gulf Coast.

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TREATING OIL FIELD EMULSIONS

Continuous testing and selective use of wetting agents, heat and settling are fundamentals of economic emulsion treating. Theory of treating and the how of testing is presented in this article

Jack L. Wiggins
Petroleum Consultant
Austin, Texas

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STABILITY of an emulsion is determined by two ingredients, the "emulsifier," and degree of agitation. The emulsifier may assume many forms. It may be a sulfate of some metal, such as iron, zinc, aluminum, calcium carbonate, asphalt; some resinous substances, or an oil soluble organic acid. Iron sulfide, present in some crude oil, is also an emulsifying agent.

Treatment of emulsified crude petroleum (known in the field as "cut" oil) consumes considerable time, expense and equipment. Separation of oil from its attendant water is usually accomplished by applying heat and treating compounds, then allowing the liquids to settle out. Other methods, however, are also employed such as steam heat and electric dehydration.

In general, emulsion theory assumes that minute droplets of water are interspersed in a body of viscous oil, and that around each droplet of water a film is formed which prevents the droplets from joining adjacent particles of water. Polarized molecules in the film create surface tension. When electrons arrange themselves according to positive and negative poles the molecules are "polarized."

In order to encourage the water particles to coalesce, this film must be broken or destroyed. Water droplets will join to form larger drops. If the drops are sufficiently large, they will be drawn downward through the viscous oil by force of gravity. Eventually all water will be "settled out." Breaking or disturbing this film is the initial task if the emulsion is to be "broken."

Certain substances, known as "*wetting agents*," have the capacity to destroy the surface tension of this film. Modern detergents are such agents, they make water wetter. Ducks are unable to float on water containing detergents because the oily film on their feathers is broken. If water in an emulsion is treated with "wetting agents," particles join and form heavy droplets, which sink to the bottom of the settling tank.

In electrical dehydration units, an electrical charge changes the polarity of the molecules in the film, surface tension is destroyed and the water droplets coalesce. Separation is, in this manner, accomplished with electricity rather than treating compounds.

Heat. Application of heat is thought to serve in several capacities to reduce surface tension, but perhaps its primary function is to decrease the viscosity of the oil which surrounds the water droplets. If oil is less viscous, water droplets will fall through it with more rapidity. Regardless of the mechanical method of separation employed, there appears to be definite procedures in resolving an emulsion:

(1) Droplets of water must coalesce,

(2) Oil must be made less viscous by heating,

(3) Water must be given time to settle out.

Breaking the Emulsion

What steps are employed to break the film around the water droplet? This is usually accomplished with a treating compound. Men who treat oil field emulsions are convinced that no two wells will produce identical emulsions, although emulsions from the same area may have similar peculiarities.

Not only do emulsions in separated areas require different treatment, but emulsions from the same well may require different methods of treatment during the life of the well. For instance, a well producing one percent water, may form an emulsion which is very difficult to resolve. (This is called a "tight" emulsion.) Later, when the well begins to produce more water, say 10 percent, the emulsion is easier to break.

If the theory of emulsions is applied to tight emulsions, it may be readily understood how small amounts of water, broken into small droplets and interspersed throughout the body of the oil, would hang suspended, growing no larger because they would rarely have an opportunity to touch one another. If a great amount of water is present, however, the drops collide frequently, and coalesce, forming large droplets which fall rapidly.

Oilmen find fresh water emulsions more difficult to resolve than those containing salt water.

Fresh water droplets weigh less, and are not inclined to fall as rapidly as heavier droplets of salt water. For this reason emulsions containing small amounts of fresh water may present a difficult treating problem.

Obviously, any compound which attacks the film of a water droplet, must first contact the droplet. Treating experts therefore recommend that the compound be added as soon as practical in the well stream. There is, however, no hard and fast rule for the addition of treating compound, so long as it eventually contacts the film of the water droplet.

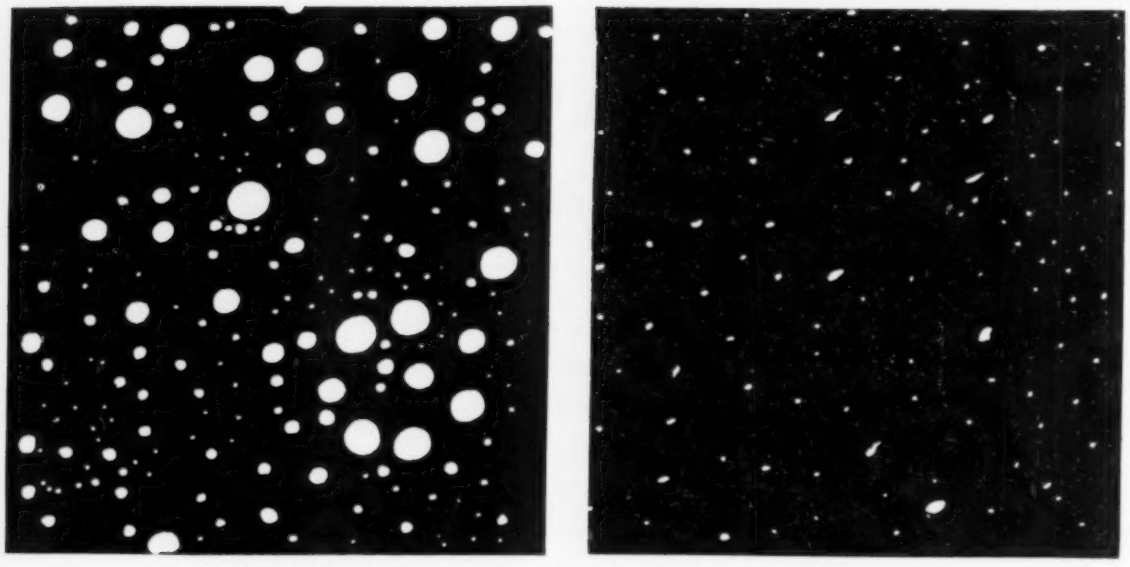

FIG. 1. Emulsion in illustration at left contains 40 percent of water in a low gravity crude. A "tight" emulsion in 25 percent water content is shown at right above.

Adding Treating Compounds

Addition of treating compounds is accomplished in several ways: (1) Batch treating, (2) adding to the well stream at the well head, and (3) down-hole treatment. Some method of rolling the tank must be employed where batch treating is used. Tank may be equipped with a mechanical paddle, or a stationary line connected to a strong stream of gas. The rolling, to be effective, should thoroughly mix the treating compound with the emulsion.

Adding Treating Compounds To The Well Stream

Treating problems are usually anticipated in the design of lease installations, and engineers concerned with design where emulsions are expected, in most instances, recommend several cardinal rules.

First they suggest the addition of treating compounds to potential emulsion-forming oil-water mixtures as soon as possible. This is divided into above-ground and below-ground treating. They reason that treating compounds can be added to good advantage at the bottom of the hole, before the water is dispersed by the effects of agitation through the fittings, chokes, and constrictions in the well bore and above-ground lines.

If the treating compounds reach the bottom of the hole, tight emulsions will never be formed and those emulsions already formed will have time to break out. Water settling will be more rapid in the gun barrel or lease tank. Bottom-of-the-hole emulsion treating requires special pumping equipment. This equipment will be described later.

Above-ground flow-line treating. Oil on many leases is treated by the widely accepted method of above-ground addition of treating compounds. This system uses pumps which force compounds into the flow line. Treating engineers recommend the installation of pumps to add treating compounds as soon as possible after the oil comes to the surface. Reasons for this are: (1) Early injection allows more treating time, (2) movement of oil through fittings mixes the treating compound with the stream of liquid, preventing further emulsification, and (3) oil at the well head is hotter and less viscous, thereby allowing free water to fall out easily, and without immediate addition of heat.

Bottom-hole treating. Some producers have found it profitable to treat emulsions by injecting treating compounds at the bottom of the hole. This method of treating is usually employed where the percentage of water production is high.

This system demands a liquid operated pump at the end of the production string, usually hanging on the tubing. The pump is powered by liquid which is forced down the hole by a bank of gas engines and centrifugal pumps at the surface. Engines usually serve an entire lease. Oil forced into the hole is clean, treated oil, used as a vehicle to carry the treating compound.

Treating Compounds

Most treating compounds contain a water soluble base, all of them will make a solution with xylol or isopropyl alcohol. Some are soluble in oil. A great deal of secrecy surrounds the manufacture of these compounds. Each manufacturer periodically offers compounds described as new and more effective. Each new compound has a symbol of its own, such as F-28, or G-164.

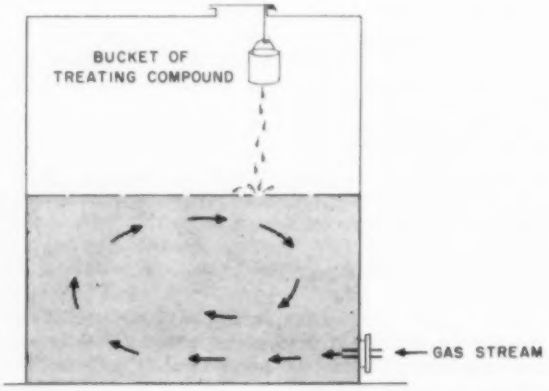

FIG. 2. Treating compound may be applied by a simple lubricator. A gallon bucket may be made into a lubricator which allows the treating compound to drop steadily into the tank. The nail should be large and left in hole, serving as a plug which will regulate the flow of the treating compound to a drop-by-drop application.

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Despite the secrecy surrounding the manufacture of treating compounds, it stands to reason that all of them must, if successful, exhibit the property of reducing surface tension of the water droplet, allowing the interspersed globules to coalesce and fall by force of gravity. Many common detergents used in the kitchen will have this same effect, although it is not being suggested that established treating compounds be forsaken for kitchen detergents.

When the treating engineer undertakes to select a treating compound he goes through a calculated series of treating tests which he presumes will result in the selection of a treating compound which does the best job at the least cost. Regardless of the treating compound selected, it must be injected with the flow system in a minute but steady, nonvarying amount, which may be as little as one drop every minute or one pint in 24 hours.

Chemical Pumps

Injection of treating compounds requires equipment having the ability to deliver a steady and minute amount of sticky liquid day in and day out without mechanical failure, and derive its power from gas pressure or some other form of energy readily available to the well site. These devices are known as "chemical pumps."

Most chemical pumps are adjustable, and may be set to deliver a definite amount of compound over a 24-hour period. Many chemical pumps are operated by applying gas pressure to a diaphragm, or a cylinder. The cylinder or diaphragm moves a plunger across a feed port, and chemical compound is pumped into the emulsion line. The diaphragm, or a system of gears, using the line gas pressure as a source of energy, gives enough mechanical advantage to move the liquid treating compound into the emulsion. Several types of pumps and pump installations are used.

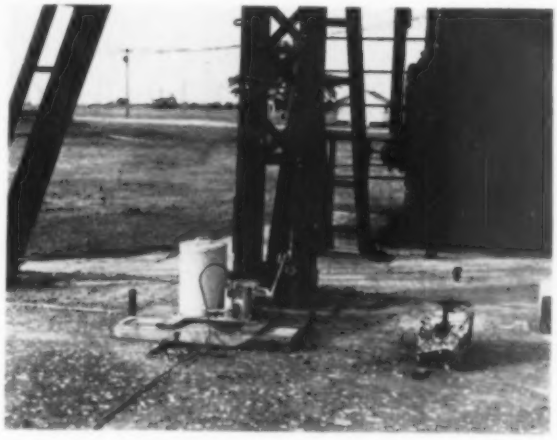
Care of chemical pumps. Chemical pumps are rugged in construction and operate for years without attention. However a few simple precautions will prevent chemical pump failures. In the oil field it has been customary to place pumps in the open without protection from sand, sun, and rain. Sand acts as an abrasive and cuts out cups and plunger shafts, causing parts to be replaced much sooner than would be necessary if the pump had been protected.

Pump should be kept clean. It should be overhauled at least once a year and all coagulated treating compound removed. This can be done easily by filling a barrel with hot water to which a good cleaning preparation has been added. Place pump cases and dirty parts in this solution. Upon removal, they should be hosed down and wiped off, sandpapered and given a coat of paint, except over moving parts. Pumps so overhauled will give good service. The author has seen numerous chemical pumps removed from the junk pile and upon being cleaned and adjusted, operate as good as new.

Heating Emulsions

Heat has been an effective method of resolving crude oil emulsions every since the first "poor boy" heater was built. The use of heat has undeniable advantages, but it is employed by most engineers only when "cold treating" proves unsatisfactory, since heat drives light ends out of solution, which may be lost. Recent treating equipment has been designed to prevent waste of light ends, and as a consequence there appears on many leases such items as weight-loaded hatches on stock tanks, gas lines which return vapors to liquid tanks, flumes, and other equipment designed to liquefy light-end gases and return them to stable products.

Heat is thought to serve several purposes in breaking crude oil emusions. First, it makes oil thinner by decreasing its viscosity. Viscosity is defined as "resistance to flow." If the oil is thinner by having been heated, the water particles may fall through it more rapidly, thereby reducing the settling time. Second, heat causes what is known as the Brownian Movement, a circulating tendency of liquid molecules when heat is applied. This movement causes the water particles to contact each other, to coalesce, and to fall in



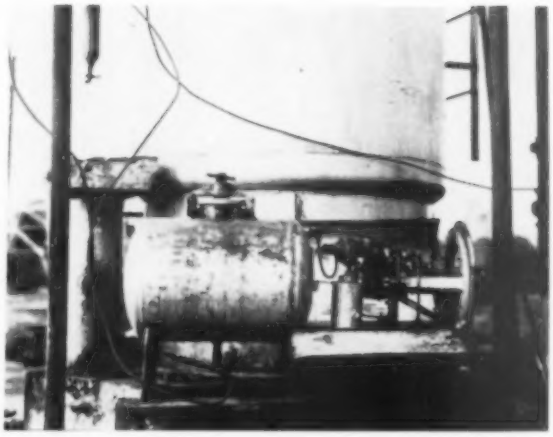


FIG. 3. Chemical pump installations used in treatment of emulsions. (Top) Chemical injector power by the movement of pumping jack. (Center) Gas driven diaphragm type pump utilizing lease gas. (Bottom) Bank of chemical pumps used in a centralized heater-treater battery.

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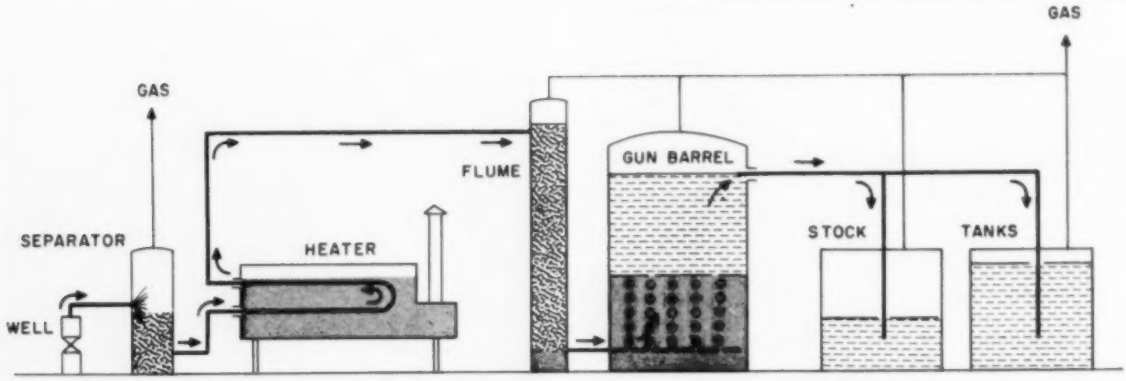
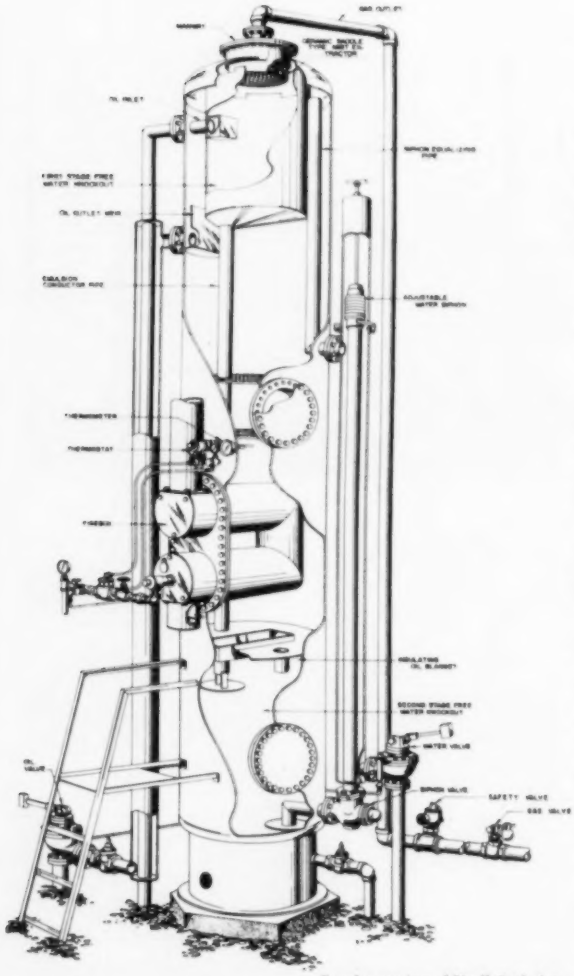


FIG. 4. Typical emulsion treating arrangement. Basic steps include injection of treating compounds, agitation, heating, settling, and separation.



Drawing courtesy of Sivalls Tank, Inc.

FIG. 5. Heater-treater is a combination of all lease treating equipment (except the separator) within one shell. It has virtually replaced large number of components shown in Fig. 4.

large drops to the bottom of the settling tank. Heat is thought by some to assist in the rupture of the film surrounding the water droplets.

Heat-applying equipment. Early in the history of emulsion treatment, the oil and water mixture was sent from the well through coils buried in a gas or oil furnace. Oil was heated as it passed through the coils, emulsions broken, light ends were lost, fires were prevalent, and the system was generally wasteful. This was a crude form of the direct heater, used today.

Direct heaters are quick, efficient, and initial cost is relatively low. On the other hand it is wasteful (unless light ends are captured) dangerous, and requires constant supervision. Scale may form on the oil side of the fire box, preventing a transfer of heat from the fire-box to the oil emulsion. Heat collects in steel walls under this scale, softens and buckles the metal, which eventually ruptures, allowing oil to flow into the fire-box. The resultant blaze, if not extinguished, is fed by the incoming oil stream.

Indirect heater: Another type is the indirect heater. Oil is flowed through tubes which are immersed in water which in turn is heated by a fire-tube.

An indirect heater has the advantage of maintaining a constant temperature throughout and over a long period of time. Hot spots are not as likely to occur, because calcium content of the heating water can be controlled.

The indirect heater has the disadvantage of requiring several hours to heat after it has been out of service, making it impossible to treat oil immediately.

In corrosive areas some innovations have been added to prevent deterioration of steel vessels, which are particularly susceptible to attacks by hydrogen sulfide. In one West Texas installation which the author witnessed, the wash tank was constructed of redwood, thereby eliminating the metal tank. Emulsion was heated by steam passed through a closed coil of cast iron and nickel alloy. Make-up water was treated for hardness before being added to the closed system. Emulsion added to the wash tank passed over the coils for heating, but both the nickel-iron alloy and the wooden tank were impervious to the effects of corrosive elements.

In other instances wash tanks are constructed of wood. The flume, usually a steel pipe, was made of a material composed of cement and asbestos which is impervious to corrosive attacks.

Steam Treating

A well-known method of treating oil emulsions is the steam treater. It is employed in West Texas, where corrosive oil emulsions are especially difficult to separate. Steamer is usually fired by kerosine and operates at several hundred pounds of steam pressure. Steam is jetted into the

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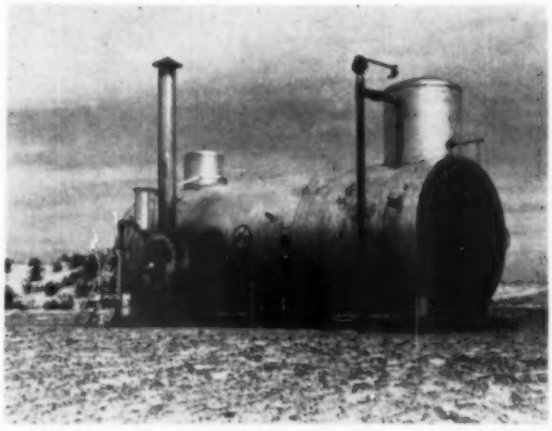
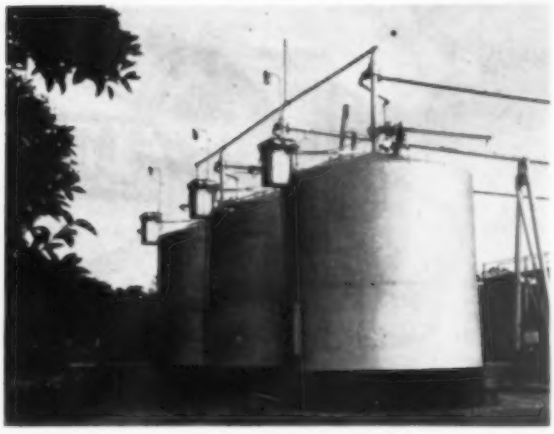


(a)



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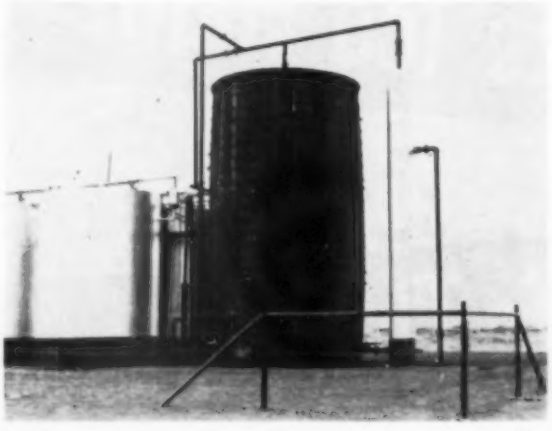

(c)

(d)

(e)

FIG. 6. Typical heater-treater installations include a number of types. Shown above are (a) a horizontal heater-treater, (b) electrical dehydrators, (c) treating system with wooden settling tank, (d) vertical heater-treater, and (e) what is commonly called a jug type heater.

stock tank of emulsion through a specially constructed nozzle in the tank wall.

Steamer meets two emulsion-breaking requirements. It heats emulsion and reduces viscosity of the oil. As the steam condenses it leaves droplets of water in the body of the oil which join droplets already there, forming larger droplets.

Settling Time

After crude oil emulsions have been treated by addition of treating compounds, agitation, or heat, the water may begin to break away from the oil in large droplets. At this point in the treating process the emulsion requires a relatively quiet tank where the settling may be completed. Some treating experts contend that settling time is the only requirement for separating oil and water. Necessities of production, however, require settling time to be relatively short, and consequently heat and treating compounds are aids in decreasing settling time.

If this view has any merit, then it would be impossible to treat emulsions without affording adequate settling time at some point in the process. It may be well here, to illustrate a typical arrangement of treating equipment as it can be found in many fields. Many variations of the flow treating system are in existence, depending on the particular local situation.

Basically, all flow treating systems employ the same functional devices. There may be refinements, or eliminations, depending on the treating problem. Essential elements of emulsion treating follow the outline below:

1. Treating compound added to emulsion.
2. Emulsion agitated by pump, separator, or flow through fittings or choke.
3. Emulsion heated. (This heated emulsion may be

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omitted in some instances where "cold treating" is sufficient.)

4. Pass heated oil through a flume where liberated gases may be separated, allowing the treated emulsion to approach some degree of stability.
5. Emulsion is passed into the bottom of a settling tank, where it is broken into drops by a spreader, and allowed to rise through a warm wash water to be "scrubbed" for water particles. This wash will at times be implemented with a hay-section, water soaked, to which water particles will adhere as they impinge themselves on the straw.

Water remaining in the oil will settle out still more if the oil is allowed to remain undisturbed. Clean oil is drained off the top section, a level of oil being maintained by the outlet to the stock-tank. Warm water, now removed from the oil, is dumped by a level control system. This level control may be a siphon or a liquid level controlled dump valve.

Gas liberated is held under a slight pressure of six to eight ounces by weight-loaded hatches on lease tanks, is condensed by vapor traps and is carried away to field condensers and compressors, used for lease fuel, sold to gas plants, and in some cases it is flared, wasted, and burned. In some installations the heat exchanger is employed to pre-heat oil as it enters the heater-treater. The heater-treater is the name given an installation which in most instances performs the functions listed above.

Engineering Emulsion Treating Program

To approach the most economical treating program on a lease, the person in charge may profit by considering several axioms:

- No two emulsions are identical, even though produced from adjacent wells, and treating methods effective with one emulsion may or may not be effective with another.
- It is not necessarily true that if a little chemical is effective more chemical will be more effective. The ideal amount of treating compound to use is the least amount that will result in clean oil. Too much chemical, or the wrong kind of chemical, may result in the accumulation of excessive interface (an unbreakable emulsion between layers of oil and water).
- All treated emulsions must be given time to settle out. Heat, and treating compounds, do not dispense with settling time, they only accelerate settling.
- Emulsions grow more difficult to treat with age. In the ideal situation, emulsions are treated before they form, while forming, or immediately after formation.
- In selection of treating methods, delay the use of heat until it becomes necessary, then the degree of heat and the amount of chemical must be thought of as inter-related factors.

The Bottle Test

Selection of economical lease practices in the treating of emulsions is accomplished through a series of trial and error experiments, the most important of which is called *bottle testing*. This test requires that emulsion samples be caught in bottles, and that measured amounts of chemical and heat be added. The experimenter must realize that the success is largely dependent upon his ability to accurately interpret his observations, and to maintain an accurate record of each test.

Principles of comparative analysis must be followed.

1. Sample of emulsion used must be identical with the emulsion that will be treated in the flow system on the lease. For instance, the sample will be taken at approximately the same point where chemical is applied to the lease system. If chemical is added at the well head, the sample for testing should be taken there also.
2. Sample should not be contaminated in any degree with a chemical compound. All samples should be taken upstream from the injection point, or the chemical pump should be shut down.
3. Measurements of chemicals, heat, and settling times must be accurate and consistent.
4. Records must be kept on each series of tests and effort must be made to eliminate human errors.

Sample for treating should be taken when the well is producing at its normal rate. It should be made in the field. The tester may use a gallon tin bucket with a spout or spigot for catching the sample. He should begin testing immediately. Samples should be taken at the point where chemical is to be added.

Testing Samples

There are two schools of thought of application of chemicals in the bottle test. One school insists that chemicals should be added in original form, since any diluent may adversely affect the accuracy of the results. Second school contends that undiluted chemicals are too viscous to be measurable, requiring the addition of amounts as small as 1/1000 cc.

The treater must decide for himself which procedure to follow. Those who use solutions usually prepare them by adding two parts of treating compounds to 98 parts of diluent. Diluent may be Benzol, but since it evaporates rapidly, a diluent of one part isopropyl alcohol and three parts of xylol, has been found more satisfactory. Several solutions of compounds should be prepared and placed in two ounce, wide-mouth jars.

FIG. 7. Pipeline gage cuts a tank sample before grinding it out.

Ratio test. Place 100 cc of a fresh sample of emulsion in each of three six-ounce square prescription bottles fitted with screw caps. Add 2/10, 4/10 and 6/10 cubic centimeters (cc) of a previously selected diluted treating compound to each bottle respectively, shake with 100 to 200 strokes of 12 in. each, then allow the treated emulsion to settle. This test simulates actual lease conditions inasmuch as (1) the treating compound is added in a measured amount, (2) it is mixed with the emulsion through agitation and, (3) it is allowed to settle.

Observe the glass sides of the bottles. If water collects and settles to the bottom, if the color changes, if there is a definite line between water and oil, then treating is taking place. Emulsions are usually some shade of brown, whereas most clean oil is dark green or black.

By visual observation, select the bottle in which the emulsion is breaking the most satisfactorily. If none of the bottles show evidence of successful treating, the ratio test should be continued with different compounds until one is found which will separate the oil and water.

If none of the compounds will treat the emulsion cold.

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FRACTURE
ACIDIZE
SWAB *and* TEST

as many intervals as required

... in one round trip

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with BAKER RETRIEVABLE BRIDGE PLUG *and...*

SETS AND PACKS OFF AGAINST PRESSURE DIFFERENTIALS FROM EITHER ABOVE OR BELOW

After the Retrievable Bridge Plug has been run to the desired depth and released, it will automatically set and pack off against pressure differentials established from either above or below the tool.

CAN BE RUN IN AND RETRIEVED EASILY... OR MOVED AND RESET AS MANY TIMES AS REQUIRED

The number of times that the Retrievable Bridge Plug can be released, moved and reset is limited only by the number of operations in the well that require its use.

NUMEROUS ECONOMICAL APPLICATIONS

Used WITH the Baker Full-Bore Retrievable Cementer for:

(a) *Straddle Operations*
The distance to be straddled is not limited by the made-up length of tool.

(b) *MULTIPLE Zone or Selective Testing, Fracturing, Acidizing*

Used BY ITSELF for:

(a) "Down-the-casing" Fracturing or Acidizing

(b) Testing operations

(c) Temporary pressure containment to permit repair to or removal of well head equipment with safety.

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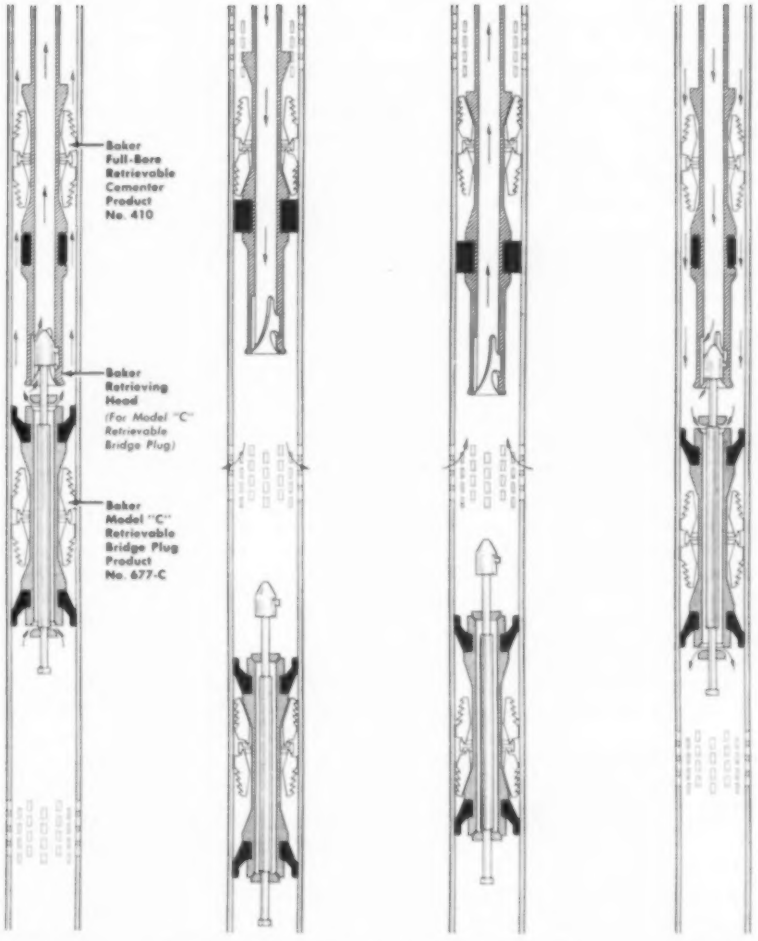
TYPICAL OPERATION


Baker Full-Bore Retrievable Cementer Product No. 410
Baker Retrieving Head (For Model "C" Retrievable Bridge Plug)
Baker Model "C" Retrievable Bridge Plug Product No. 677-C

RUNNING-IN
Retrievable Bridge Plug being run into well on bottom of Full-Bore Cementer through use of Retrieving Head. Note fluid by-pass.

FRACTURING OR ACIDIZING
Plug should be pressure tested after release. Cementer is released, raised above perforations and reset for pressure operations.

SWABBING, TESTING
Note how the reversal of pressure differential has transferred load from one set of slips to the other (both cementer and plug).

RETRIEVING
Plug and Cementer being moved to next set of perforations—or retrieved from well. Valves in plug open to permit fluid by-pass.

Product No. 410

BAKER **FULL-BORE** RETRIEVABLE CEMENTER

HOLDS PRESSURE FROM EITHER ABOVE OR BELOW

Two sets of opposed slips enable the cementer to hold pressure from either above or below. Casing can be tested before squeeze—and the tubing also, if the Baker Full-Bore Tubing Tester is used.

FULL BORE CONSTRUCTION

Permits Passage of Tubing Perforators or Instruments—Assists in Preventing "Screen-Out" on Fracturing Jobs

The Full Bore through the Cementer (and Tester if used) is in reality a continuation of the bore through the tubing.

This continuous full ID passage not only permits passage of tubing perforators or instruments but assists in preventing "Screen-Out" (sand dropping out of the oil) and subsequent plugging of the tubing in fracturing jobs.

IDEAL STRADDLE TOOL WHEN USED WITH BAKER RETRIEVABLE BRIDGE PLUG

The operation of the Cementer setting mechanism makes it easy (through the use of the Retrievable Bridge Plug Retrieving Head) to release and pick-up the Baker Retrievable Bridge Plug. It is in fact the ideal partner to the Retrievable Bridge Plug for selective multiple-zone or single-zone operations.

these products and their application

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then the same test should be repeated, heating the samples until a successful separation is accomplished, noting the temperature of each test. The amount of settling time may also vary.

Eventually a compound which will break the emulsion will be found, and in the process of ratio testing, several compounds may appear equally effective. These compounds should be noted, for the selection of a compound which will most effectively treat the emulsion is the next step.

This process is a comparison of the effect of the same amounts of different compounds, whereas the ratio test was a comparison of different amounts of the same compounds.

Fill six prescription bottles with fresh emulsion and add the same amount of different treating compound solutions to each sample, using the previous ratio tests as a guide in selecting the first amount. Compare the effect of each solution on the cold emulsion. Heat the samples and compare the effect of each solution on heated samples. Record your choices in order of the most and the least effective.

Pour out the samples, wash the bottles, and add fresh emulsion samples. Reduce the amount of treating compound added, and perform a test in which the number of agitating shakes, the settling time and the amount of heat added is identical with the previous test. Select the most effective compound and record all results.

Continue this procedure until all but one of the samples have been eliminated after failing to show proper treating. Continue to reduce the amount of treating compound which was added to the one remaining sample until no treating is observed.

In this way the least amount of the most effective treating compound is determined. To be certain that this amount of compound has successfully treated the oil, it is necessary that a centrifuge test be performed.

Centrifugal Test

Centrifuge testing in the field is called a "shake out." Its purpose is to separate the heavier water in an emulsion by forcing it to the bottom of a whirling test tube with centrifugal force.

There are several accepted methods of performing a centrifuge test. The tester should determine which method is used by the pipeline gager, and follow that method. For detailed procedure, reference should be made to, American Society of Testing Materials, D-96, and American Petroleum Institute, Code 25.

The ASTM Code requires the use of cone shaped and pear shaped test tubes, whereas the API Code permits the use of a smaller test tube with a capacity of 12.5 cc. The API test also permits the use of other solvents other than Benzol to "cut" the sample, and heating may be omitted where high paraffin content is not found. Accurate testing often requires the application of heat as well as solvent to the sample.

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Usual procedure in the field is to fill the test tubes half full with oil, and then add a solvent, mixing thoroughly. Heat if necessary and place in a centrifuge, whirling about 1500 rpm for 3 to 10 minutes. Samples are then removed and the percentage of water and bottom sediments (BS&W) is recorded to the nearest 2/10 percent.

After a centrifuge test has been performed, it is possible to determine if the treating has been effective. If the treated oil contains more than 2/10 of one percent, or if it does not meet pipeline specifications, other tests may be necessary.

In bottle testing the following precautions should be rigidly observed:

1. All bottles should be clean and free of treating compound before adding emulsion samples (rinse in kerosine, drain and dry; rinse with xylol and allow to drain, mouth downward; dry with a clean cloth.)
2. Pipette used for measuring compounds should be rinsed thoroughly after each use to prevent contamination of compounds.
3. Bottle test should approach lease conditions as closely as possible. For instance, if no emulsion heater is available on the lease, do not use heat in the bottle testing, and if there is only a small amount of agitation given the emulsion in the lease system, shake the bottles only moderately.
4. Fresh samples should be used at all times, and the bottle test should be made in the field at the time the samples are taken.
5. Record all your results after each test. Do not depend on your memory.
6. In case of a doubt as to the efficacy of a treating compound, do not guess, but perform a centrifuge test.

Treating oil field emulsions is a continual and varying necessity if the most economical methods are to prevail. This is apparent if one acknowledges changing conditions in production. In order to meet these changing conditions it is necessary for the pumper or treating engineers to perform periodical bottle tests and centrifuge tests.

An efficient treating program reduces treating costs, prevents loss of production, eliminates delays in pipeline runs, and avoids excessive bottoms, tank cleanings, and carry-over of interface sludge. An efficient treating program also avoids loss of light ends, and thereby prevents gravity loss and volume shrinkage.

Many companies have found that an efficient oil treating program has paid for personnel and equipment within a very short period because it eliminates losses in oil volume, gravity, and production time.

Companies interested in more detailed training information are referred to, Mr. J. F. Smith, American Petroleum Institute, Division of Production, 300 Corrigan Tower, Dallas, Texas, and to a manual of instruction, *Treating Oil Field Emulsions*, which was prepared in cooperation with and validated by the Institute's Central Committee on Vocational Training, 1949. The Institute also assists groups in obtaining Emulsion Training Kits for the instruction of field personnel.

References

1. Bulletin 417, U.S. Bureau of Mines, G. B. Shea, *Practices and Methods of Treating and Preventing Emulsions.*
2. "Treating Oil Field Emulsions," prepared in cooperation with and validated by the Central Committee on Vocational Training of the Division of Production of the American Petroleum Institute, June 24, 1949; issued by the University of Texas.
3. *Instructor's Guide*, for the field training course, *Treating Oil Field Emulsions*, prepared by Jack L. Wiggins, as special training consultant, American Petroleum Institute, Division of Production, March 1955.
4. American Petroleum Institute Code for Measuring, Sampling, and Testing Crude Oil. (API Code 25 Seventh Edition, 1948.)

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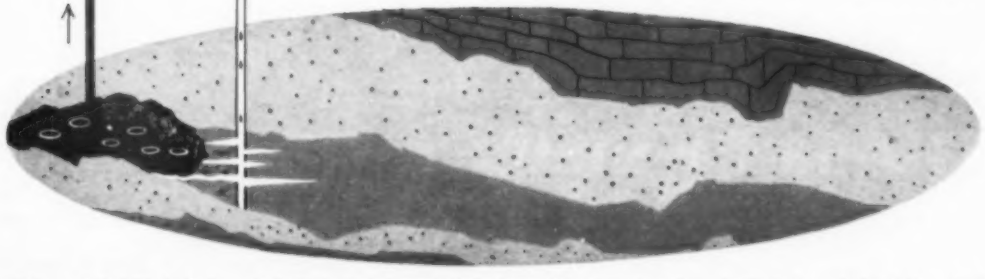

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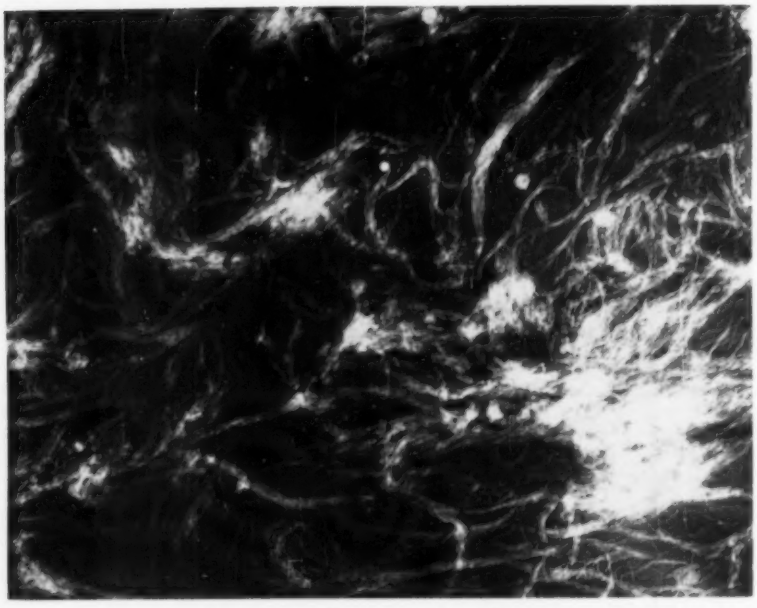

FIG. 1. **Soap fibers found in modified fracturing fluids.** This is an electron photomicrograph of a sodium soap dispersion formed in diesel oil and magnified originally 100 million times. (Original photograph reduced here.)

A. R. Hendrickson, L. E. Nesbitt and B. D. Oakes
Dowell Incorporated, Tulsa, Oklahoma

MOST recent general development in fracturing fluids has been a soap-oil dispersion that combines the best features of other fracturing fluids and overcomes many of their disadvantages. Such soaps, when added to hydrocarbon fracturing fluids, produce micelles, or microscopic threads, that lower fluid loss and increase sand-carrying capacity of the fluid. The fluid also exhibits thixotropic properties, providing additional sand support without a corresponding increase in viscosity.

Oil-dispersible alkali metal soaps have been familiar industrial compounds for several years. The familiar phenomenon of micelle formation of soaps in aqueous solutions also occurs in non-aqueous media.[1,2,3,4,5,6,7]

Because of their unique colloidal nature in non-aqueous solvents, their use has been recently extended to improve the characteristics of formation fracturing fluids, such as kerosine, diesel fuel, and crude oil. A variety of fluids have been employed to open fractures and carry propping agents, among which are gels, emulsions and refined oils. These fluids have been modified in the past few years to overcome and eliminate certain difficulties that were encountered in field applications. By "in-situ" neutralization of long chain aliphatic organic acids in a hydrocarbon media, a sodium-soap dispersion results that considerably improves the characteristics of fracturing fluids used today.

Properties of Oil-Soluble Soaps

Low sand-falling rate and low fluid loss, two necessary and important features of such fracturing fluids, can be obtained without increasing the apparent viscosity, as measured under high rates of shear. Viscosity itself is of little importance in this type of system. The phenomena of low sand-falling rate and low fluid loss are achieved by the formation of micelles and their apparent aggregation within the oil base.

The resulting and most important characteristic of this non-aqueous soap system is its thixotropy, or pseudoplastic flow properties. This provides adequate support of the propping sand in the fracturing fluid, without a corresponding increase in the viscosity under high rates of shear.

Micelle dispersion is prepared by first dissolving the organic acid in the oil base, after which it is neutralized "in-situ" by the addition of a concentrated aqueous solution of sodium hydroxide. The mixture is then agitated in order to disperse the caustic solution throughout the oil and neutralize the acid. A number of different types of fatty acids can be used in this manner to prepare modified oil-base fracturing fluids.

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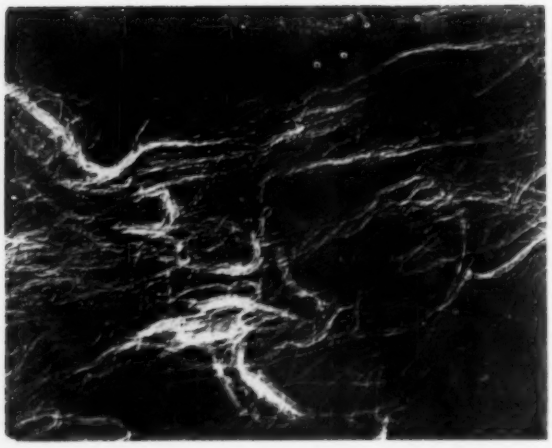

FIG. 2. **Matted network of micelles** in another modified fluid as seen by the electron microscope. This thread-like structure is obtained by "in-situ" neutralization, and increases the sand suspending properties without excessive friction losses during treatment.

FIG. 3. **Chunky type of soap crystals** not particularly desirable in a gelled fracturing fluid. As shown in this electron photomicrograph, this type of structure does not exhibit the sand-supporting ability as shown in Fig. 1 and 2.

The structure of micelles in non-aqueous media is different than that of micelles occurring in aqueous solutions. In the oil systems, the micelles have the polar portions of the carboxylate molecule buried in a central core,[7] rather than distributed over the outer surface, as in aqueous systems. These polar terminals interact, either by dipole attraction or by specific hydrogen bonding of certain atoms. This reaction or association provides energy for the maintenance of the micelle structure and inhibits further growth.

"In-situ" neutralization of the acid by an aqueous solution of sodium hydroxide, rather than the anhydrous form, introduces another factor in micelle structure. Since the core of the micelle described above is hydrophilic, the water will tend to be trapped in this center. This apparently provides an opportunity for aggregation of the fundamental micelle cores into more extensive structures throughout the non-aqueous media.

The most important property of these soap-oil systems is demonstrated by the complete destruction of the apparent viscosity at high rates of shear. This characteristic is typical of pseudoplastic fluids. This is illustrated by viscosity measurements of the soap-oil system at various speeds of shear. Table 1 presents data obtained with various instruments, and compares these viscosities with measurements of a semi-refined oil[9] commonly used as fracturing fluid.

In the soap-oil system, the final degree of thickening or modification that is obtained is dependent upon the degree of agitation the dispersion receives in preparation. A higher apparent viscosity of the modified oil is obtained by a high degree of agitation. For example, passing the modified oil through a homogenizer, after preliminary mixing by a laboratory stirrer, greatly increases its apparent viscosity. Repeated passes through the homogenizer further increases the viscosity until a plateau is reached.

Soap Concentration and Viscosity

Fig. 4 illustrates the effect of soap concentration on the viscosity of a medium API gravity crude oil. The curve represents the viscosity obtained by "in-situ" neutralization of various concentrations of a fatty acid with aqueous sodium hydroxide, in a medium gravity Oklahoma crude oil. Viscosity measurements were made after a mixing time of 30 minutes, with a mixer stirring at a rate of 1700 to 2000 rpm.

It may be seen that the viscosity increases with concentration of soap, although the relation is not linear. Slope of the curve indicates that the most effective thickening occurs in the medium concentration range.

Soap micelle formation begins at a very low concentration, but the sharp rise in the viscosity curve may indicate the secondary aggregation of the fundamental micelle cores into an extensive network. The viscosity-vs-concentration graphs of most soap-oil systems have the same general S-shape exhibited here. Whether the curves are translated to the right or left on the concentration axis is dependent upon the API gravity of the base oil. With high gravity oils, the curve is translated to the right; with low gravity oils to the left; that is, low and medium gravity oils reach a higher apparent viscosity than do high gravity oils, at the same soap concentration.

TABLE 1 — Viscosity Measurements by Different Methods, Made on Soap-Oil System and a Semi-Refined Oil.

Method	Viscosity (cp) at 80 F. Soap-Oil System	Semi-Refined Oil
Brookfield Viscosimeter		
Spindle #2 — 60 rpm	190	190
30	270	190
12	475	190
6	780	190
Stormer Viscosimeter (600 rpm test)	23	190
Ultra-Viscoson (Rich-Roth Laboratories' Model XV)	10	190

Viscosity and Sand-Falling Rate

Fig. 5 illustrates the effect of the increased viscosity on the sand-falling rate of a medium gravity oil. Sand-falling rate[9] is essentially the rate of fall of graded 20-40 mesh sand through the oil. A low rate of fall is important since the sand, or propping agent, must remain suspended in the fracturing fluid during the fracturing treatment. A rate of 5 ft per min or less has been found satisfactory for this purpose. Sand-falling rate in water, for comparative purposes, is approximately 27 ft per min.

It can be seen from Fig. 5 that the sand-falling rate decreases as the viscosity increases. This also is dependent on the nature of the base oil. The curve is translated to the left for high gravity oils and to the right for low gravity oils.

An appreciable decrease in sand-falling rate is accomplished in the soap-oil systems without a correspondingly

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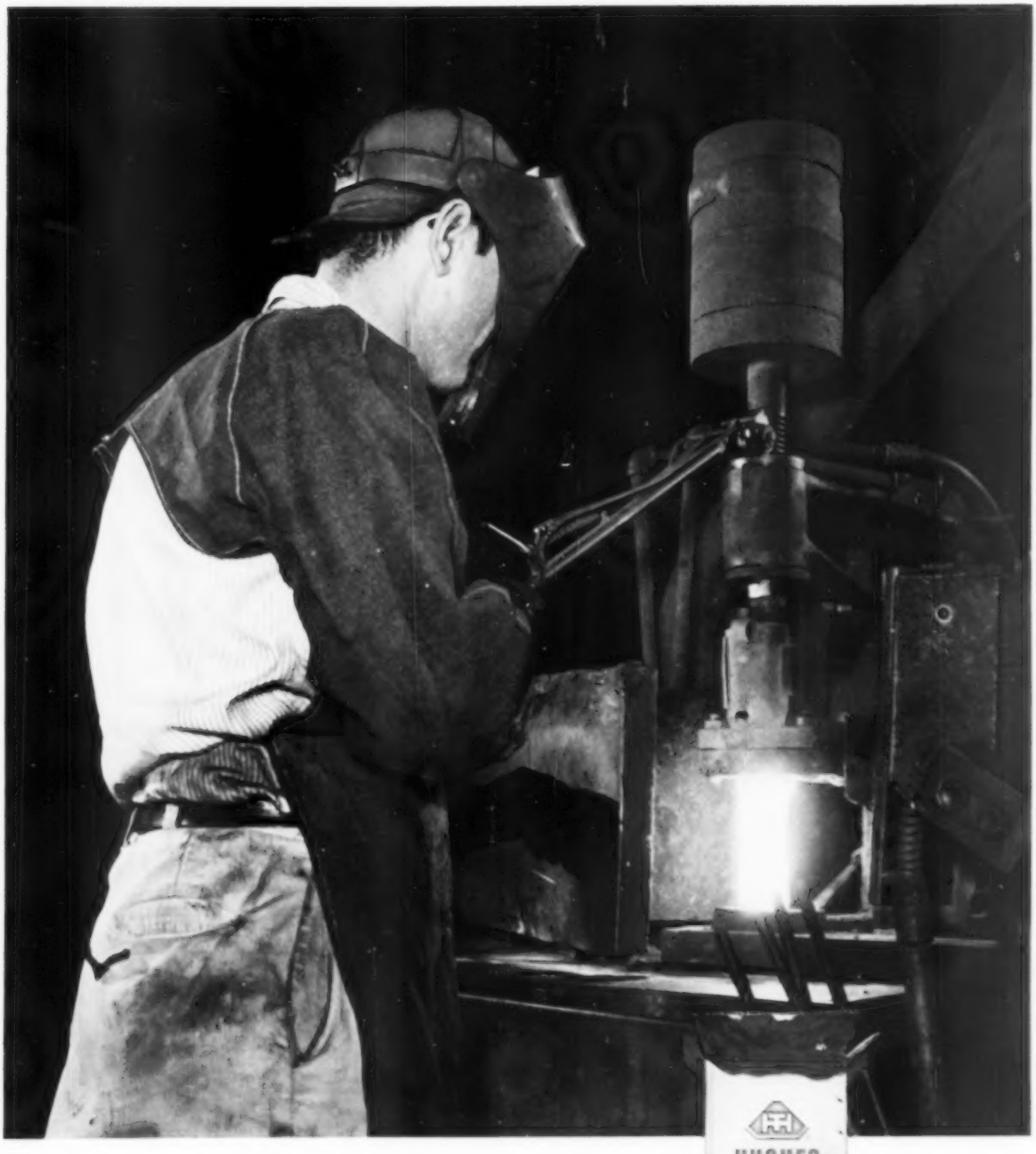

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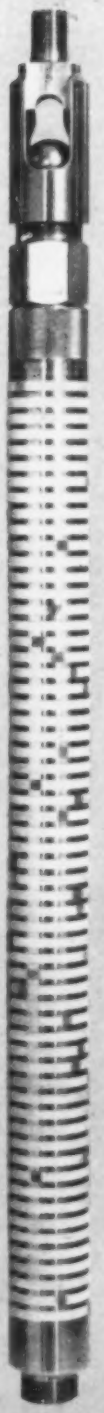

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The accurately grooved and drilled metal body of **The Martin Plunger** does not touch the barrel. Only the resilient rubber and duck rings contact the barrel. This material — with its great natural resistance to abrasion as well as its slipperyness-when-wet — has a much slower wearing action on the barrel. Most often your barrel will not need replacing. These rings have an amazing ability to take the kind of abuse that goes with oil well pumping, and this means longer runs. Plunger cost is reduced because replacing the rings costs only about one fourth as much as a new plunger, and this saving is, of course, added to the barrel saving and longer runs.

Patent No. 2,591,174

The Martin Rubber Guide Cage protects the ball from all metal contact except when it rests upon its seat. The ball is protected to such an extent that ball and seat life is usually doubled. The synthetic ball guide and stop cannot beat out because of its resilience. Its life is therefore much greater than any metal and you get this longer cage life in addition to better ball and seat life. The two guides are easily replaced when the occasion does arise.

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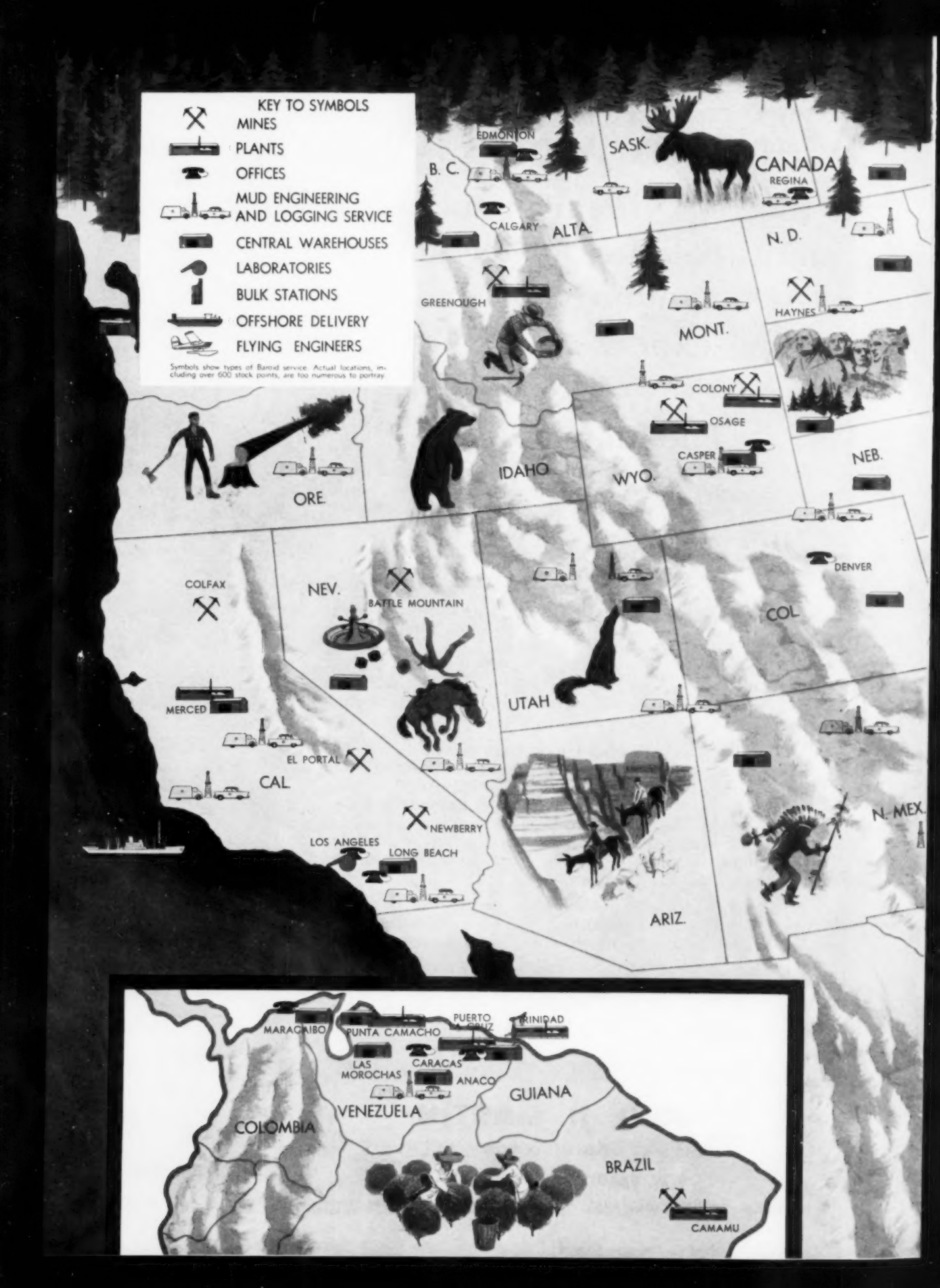
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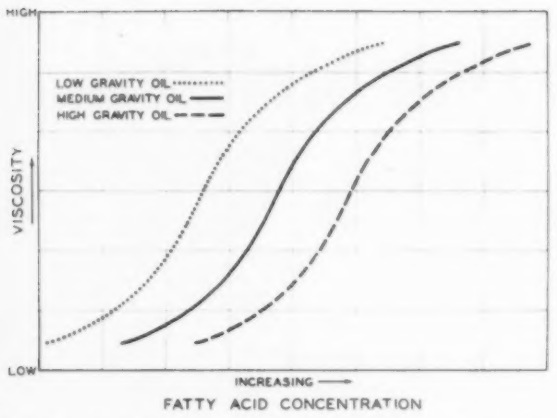

FIG. 4. **Effect of fatty acid soap** concentration on the viscosity of crude oil.

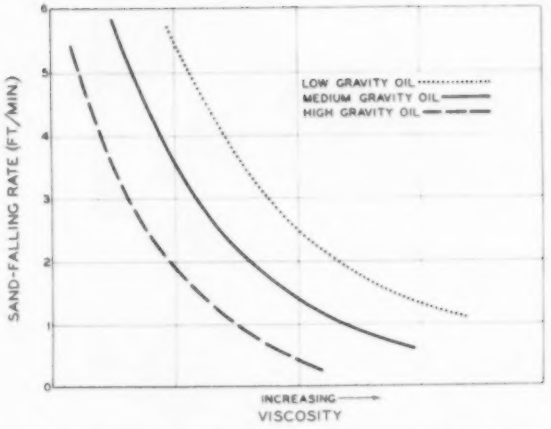

FIG. 5. **Sand-falling rate** is effected by viscosity of modified crude oil fluids.

large increase in viscosity. This may be due to the aggregation of micelles within the system and adsorption of these aggregates by the sand grains.

Effect of Water and Brine

The effect of water and brine in these soap-oil systems has been studied, specifically in relation to the apparent viscosity, fluid loss, and stability of the resulting modified oils. In this study, water content in the system was varied in two ways. Various concentrations of the aqueous sodium hydroxide solution were used in the "in-situ" neutralization of the fatty acid solution to alter the water content. A separate study was made on the effect of brine as a contaminant in the system.

Other conditions remaining unchanged, the concentrated sodium hydroxide solutions impart more apparent viscosity to the system than do the dilute solutions. At the same time, lower fluid-loss characteristics result with the more concentrated sodium hydroxide.

Low fluid-loss of a fracturing fluid permits a greater build-up of pressure during a fracture treatment, resulting in further penetration of the produced and existing fractures by a given volume of oil. Apparently, the additional water present in the more dilute alkali weakens and partially destroys the aggregation of soap micelles, perhaps by splitting the polar core from within.

Fluid loss. The micelle imparts the low fluid loss property to the modified oil. Effectiveness of the micelle depends to a large degree on the amount of water associated in the micelle. Only small amounts of water are present in the micelle core when concentrated sodium hydroxide is used in the "in-situ" reaction. This water may act as a structural tie in building the soap molecules into a strong network through hydrogen bonding.

Fluid loss of the oil is reduced by the physical bulk and strength of this network. As the amount of water in the core center of the micelles is increased, the network structure is disrupted and becomes less effective, thus permitting greater loss of fluid. These statements are generally true for most crude oils; however, high gravity oils and distillates above 50 API gravity tend to respond better to dilute solutions of the aqueous ba~2. Those oils below 50 gravity appear to have lower sand-falling rates and lower fluid-loss properties with a more concentrated solution.

Brine lowers viscosity. The presence of brine in the oil causes lower viscosities, perhaps from partial destruction of the soap micelle structure and consumption of the base to form relatively insoluble alkaline earth hydroxides. The use of greater amounts of aqueous caustic proportionate to the degree of brine contamination, will tend to overcome this effect and restore viscosity. This additional caustic apparently restores maximum micellular aggregation within the soap-oil system. Brine contains alkaline earths, barium, calcium, and magnesium, which also form soap micelles in oil systems. However, these soap micelles precipitate and do not reaggregate in the presence of water.[10] Perhaps this restoration of viscosity upon the addition of sodium hydroxide may be explained through a mechanism of equilibrium between the sodium soap and the alkaline earth soaps.

Effect of Grease Formation

Some soap-oil dispersions gel to a semi-solid grease upon prolonged heating. In laboratory tests, a concentrated aqueous sodium hydroxide solution was used to neutralize a fatty acid-oil system. This dispersion was then heated, resulting in grease formation. These greases are undesirable in a fracturing fluid, due to the difficulties they present to pumping. Such greases do not have the flow properties of the preferred soap-oil dispersions. Hotten and Birdsall[11, 12] discussed the properties of some lithium soap greases. These greases are probably the result of a more complete reaction of acid with base than occurs at the ambient temperatures of the normal fracturing fluid preparation.

Gelation of a grease which occurs upon heating is also dependent on the concentration of sodium hydroxide used. Presence of additional amounts of water, by the use of more dilute sodium hydroxide solution, increases the tendency toward grease formation. This may be due to an incorporation of water into the micellular structure to stiffen and extend it, as well as a more complete reaction of the acid and base to form a soap.

The oil medium also affects the formation of grease on heating. Higher gravity oils have a much greater tendency to form greases than do lower gravity oils. A summary of data illustrating this relation is shown in Table 2.

Tendency of high gravity oils to form greases more readily may be due to the greater ease of incorporation of the smaller molecules into the semi-solid structure, also to their greater mobility, causing a more rapid reaction.

Soap fibrils. Although the true structure of aggregation of the soap micelles

TABLE 2 — Relation Temperature Ranges of Soap-Oil Systems.

Gravity of Oils (API)	Temp. (F) of Semi-Solid Gel Formation
Above 50	Below 175
40-50	150-225
Below 40	Above 200

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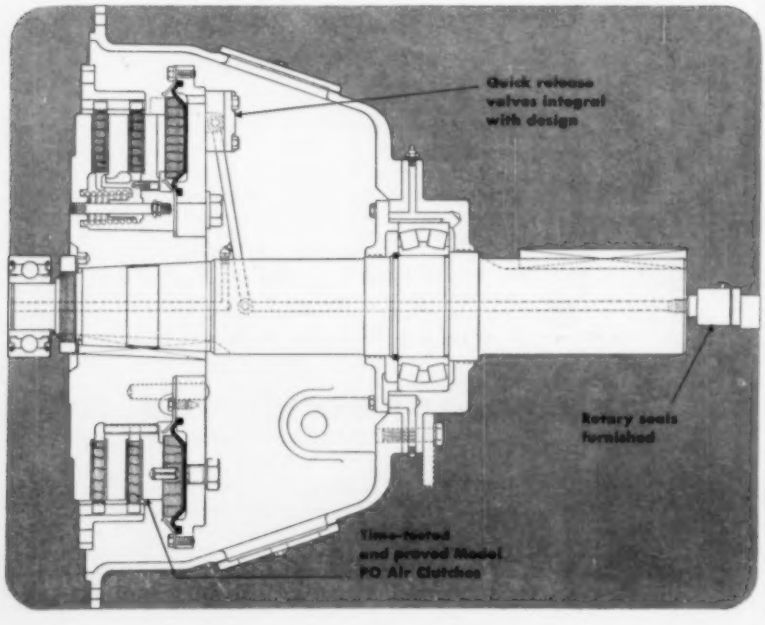

in the oil base is not known; Fig. 1 shows the soap fibers that are found in such modified oils. This is an electron photomicrograph of a sodium soap dispersion, formed "in-situ" in diesel oil, and magnified. Soap fibrils appear to be entwined randomly in loosely woven rope-like structures.

Although most of the soap appears to be in multiple aggregates, some individual strands of fibrils are present which cross and interlace with each other as well as with the larger aggregates. In addition to forming a barrier network to the free fall of sand particles, some of the soap aggregates may adsorb on the sand itself. This would tend to further decrease the rate of fall of the sand grains through the oil.

Fluid of Superior Qualities

It can be said that the desirable properties of this unique fracturing fluid, now finding wide application in well stimulation techniques, are apparently a result of the association of soap micelles into a structural network in the oil base. This micellular aggregation of the organic sodium soaps functions to give a fracturing fluid with superior qualities of pseudoplastic flow, sand suspension, and fluid loss.

This property of pseudoplastic flow is perhaps the most important feature of this type fracturing fluid, allowing it to support sand under low rates of shear, without causing a high friction pressure under increased rates of shear. The soap, present in aggregate form, tends to reduce the fluid loss property of the oil base, allowing greater extension of produced and existing fractures by a given volume of oil.

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Acknowledgment

Original paper presented at the Thirty-first Annual Fall Meeting of the Petroleum Branch of the AIME (now the Society of Petroleum Engineers) in Los Angeles, California, October 14-17, 1956, and recently released exclusively to THE PETROLEUM ENGINEER for publication here. ★ ★ ★

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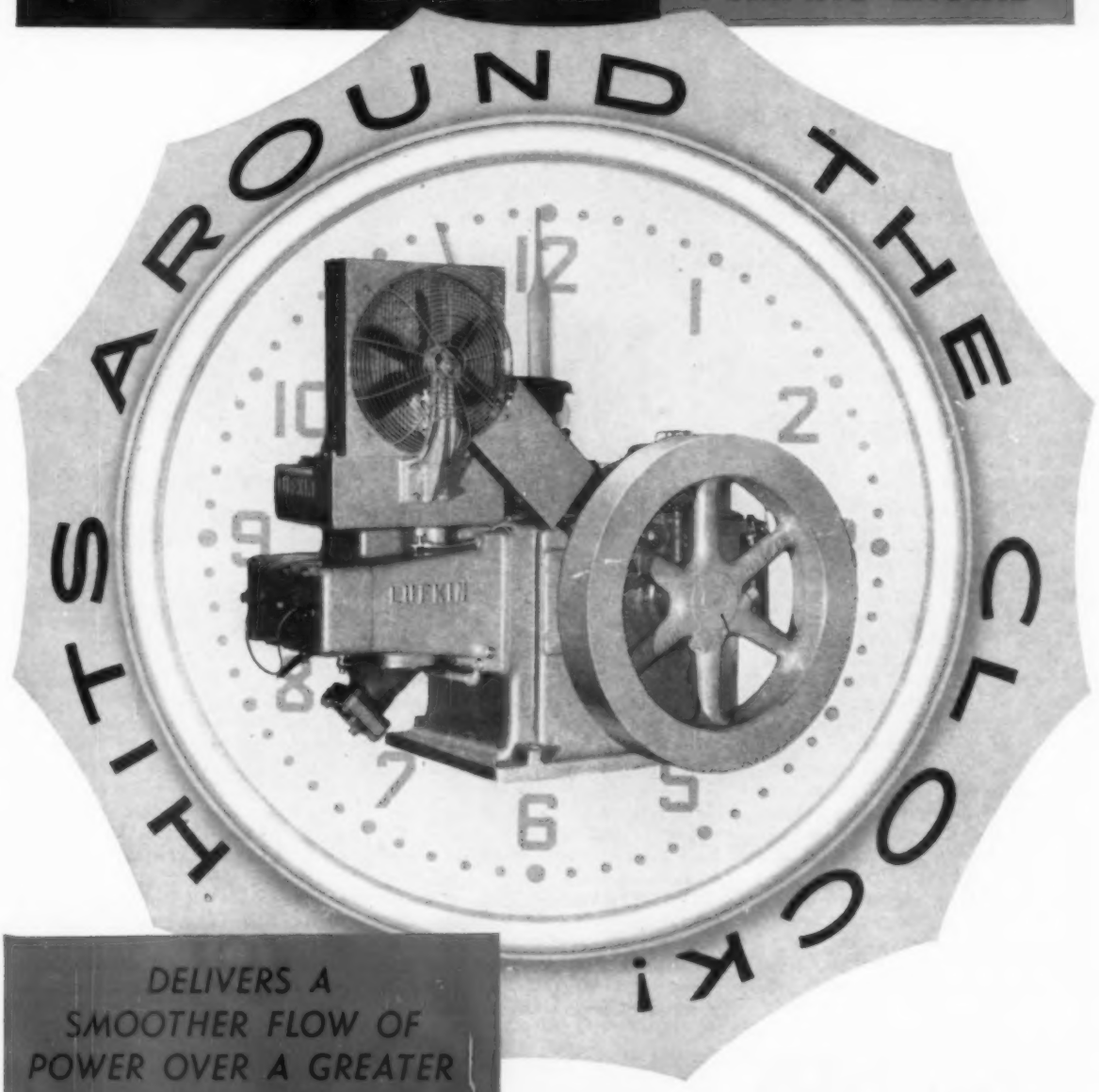

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East Texas Oil Pioneers Receive Honors and a Monument

Lone Star Steel and East Texas Chamber of Commerce commemorate discovery of U. S.'s biggest oil field

DEEP in the piney woods of East Texas and about a mile from the C. M. "Dad" Joiner discovery well that triggered the big East Texas boom, is a small immaculate roadside park. On a base of stone rests a joint of steel pipe inside of which is a time capsule containing historical documents and 100 shares of Lone Star Steel Company stock. It will be opened in 2056 A.D. Atop the shaft of steel is a bronze bust of Joe Roughneck, Lone Star Steel's symbol of the oil industry. Called Pioneer Park, this memorial commemorates the efforts of the early oil man in the discovery and development of the giant East Texas field.

Lone Star Steel Company and the East Texas Chamber of Commerce joined forces to execute this memorial. Prominent civic leaders and members of the Texas Railroad Commission in ceremonies lauded the accomplishments of the industry dating from 1930 when the East Texas field was discovered. Jake L. Hamon, chairman of the board of API, declared that the industry's number one problem is "public relations . . . for in an atmosphere of sympathetic understanding by the general public, nationwide, all the problems pertinent to the mechanics of our business will take care of themselves." Judge Olin Culberson, veteran chairman of the Railroad Commission, reviewed the constant threat to remove control of the oil industry from the individual states and of vesting this power in the federal government.

Dedication ceremonies at Pioneer Park included addresses by E. B. Germany, president of Lone Star Steel, who spoke of the days when oil men made bargains involving millions of dollars with no more than "You've got a deal."

James Aston, president of Republic National Bank, Dallas, set the stage for unveiling the monument containing the time capsule, inside of which was placed trade journals, newspapers, films, pictures, maps, 100 shares of Lone Star Steel stock, the Bible, and other documents. This capsule will be opened in 2056 A.D., but in the meantime, Republic National Bank will serve as trustee of the fund created by the stock. Income will be used to aid East Texas students to obtain college educations.

Dr. Willis Tate, president of Southern Methodist University, stated that East Texas has become the citadel of a stabilized oil industry, and noted that it had taken almost 27 years for the oil pioneers of East Texas to slow down enough to return to the spot where the era of oil conservation and stability began. As Dr. Tate spoke, the original "Dad" Joiner crew who drilled the Daisy Bradford No. 3 discovery well, assembled in front of the monument. With driller Ed Laster were D. H. May, A. W. Kirkland, Dave Cherry, James Hunt and Ernest Newman.

Following the dedication, Railroad Commissioner Bill Murray paid tribute to the East Texas pioneers and said that goals achieved in conservation serve to keep the Commission members aware of their tremendous responsibility. ★ ★ ★

Original drilling crew members who drilled the East Texas discovery well stand in front of the Pioneer Park monument. Left to right are: Dennis H. May, Sheridan, Ark.; A. W. Kirkland, Plain Dealing, La.; E. C. Laster, Shreveport, La., driller; Dave Cherry, Overton, Texas; James Hunt and Ernest Newman, both of Henderson, Texas. The steel shaft will be opened 2056 A.D.

Jake L. Hamon, chairman of the board, API, paid tribute to the pioneers.

Olin Culberson, chairman, Texas Railroad Commission, challenged the threat of federal control of oil.

E. B. Germany, Lone Star Steel president, told of pioneer's integrity in making verbal agreements involving millions.

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(*Continued on next page*)

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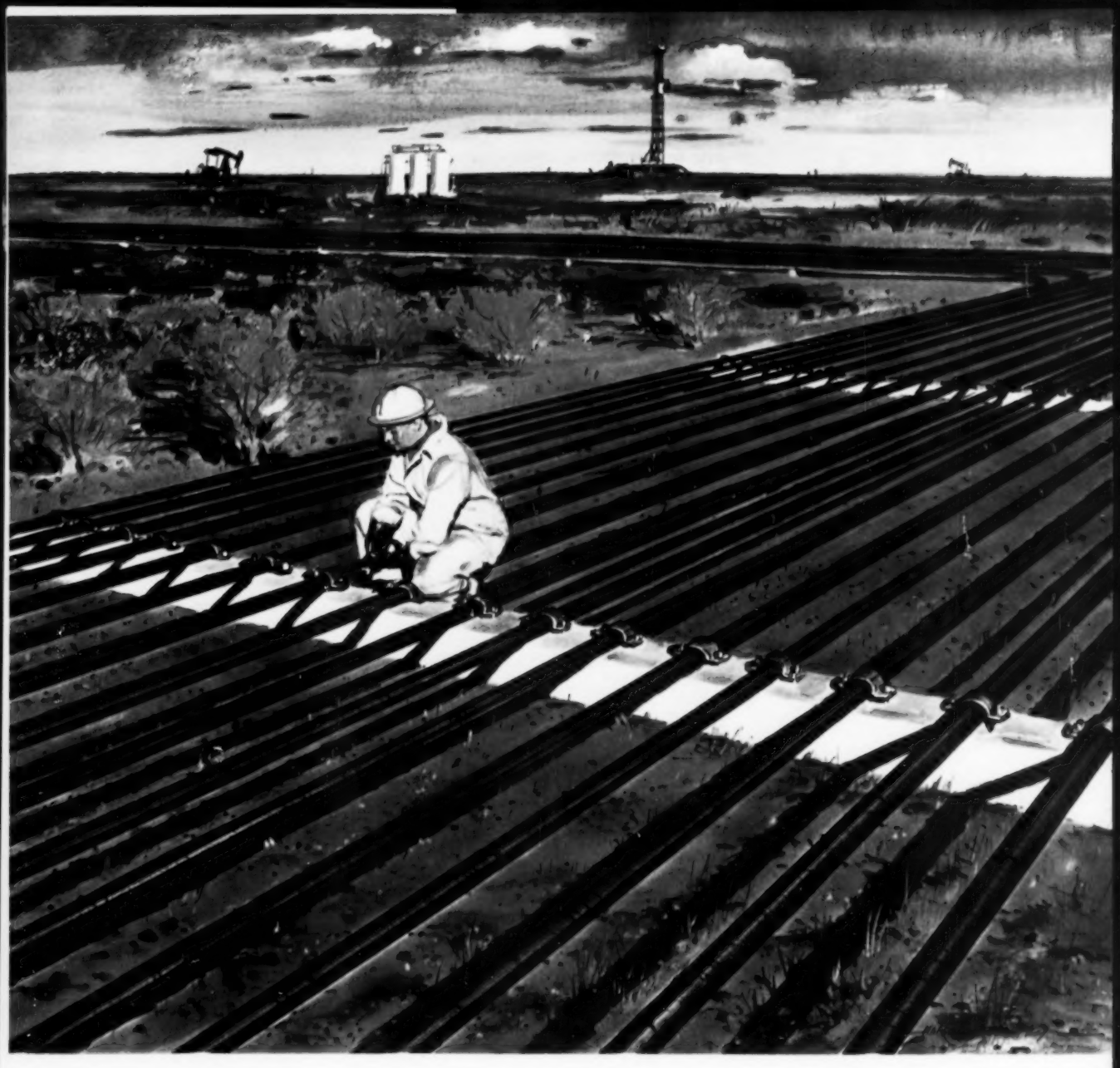

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NATIONAL BLUE OIL FIELD MACHINERY AND EQUIPMENT
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CATHODIC PROTECTION Of Offshore Structures

Magnolia-Continental-Newmont group reaps installation, power cost savings, extends service life by effective selection and placement of submerged protective systems

A. H. Massad
Magnolia Petroleum Company
Morgan City, Louisiana

B. G. Holmes
Magnolia Petroleum Company
Dallas, Texas

CORROSION mitigation measures cost the oil industry $4,500,000 in 1955 — and twice that much in 1956. The amount is expected to spiral higher this year.

Nature of offshore equipment and platforms in the Gulf of Mexico, valued at $150,000,000, is such that effective corrosion control is imperative.

Magnolia Petroleum Company, Continental Oil Company, and Newmont Oil Company, with Magnolia as operator, protect their offshore properties using every available means to safeguard and prolong the life of their structures. Each stationary platform ranges in cost from $250,000 to $1,000,000, depending on size and number of wells.

Magnolia protects its steel structures by three different devices. It is generally agreed that the atmospheric zone, or that portion of the structure above any wetted surface, may be adequately protected with one of many paint systems. When available, monel sheathing is used for protecting the splash zone. Cathodic protection systems are offering the most effective means of protecting the underwater zone.

Well Platforms

Platforms installed in Magnolia-Continental-Newmont operations are stationary multi-well type structures. These accommodate from 3 to 12 wells. The 3 well platform, with an average deck size of 54 by 90 ft, is normally used with a drilling tender. Deck is about 35 to 45 ft above the water line. In this type of platform there are 36 piling members with associated cross bracing, both above and below the water line. In larger platforms, or self-contained structures, between 65 and 75 piling members are used; deck section is approximately 206 by 54 ft. Also, a living quarters platform, 50 by 52 ft, is set with this structure and connected by a walkway.

Well platforms have exposed submerged areas ranging from 13,000 to 40,000 sq ft or more depending upon the type platform and water depth. These platforms are not equipped with a permanent electrical power source. For this reason, they are cathodically protected below the water line by the galvanic action of magnesium-anode systems. The systems are designed to supply a protective current density of from 2 to 4 milliamperes per sq ft of submerged bare steel surface. This range of cathodic current densities produces polarized structure-to-water potentials which vary from –0.80 to –1.0 v when measured with respect to a saturated calomel half-cell.

Magnesium-anode system most widely used for protection of offshore platforms involves suspending several free-swinging anodes from cables attached to brackets suitably distributed throughout the structure. This system permits magnesium anodes to undergo constant agitation by movement of the sea, tending to increase the natural solubility rate of magnesium in sea water. Because of this solubility rate increase, efficiency of the magnesium anodes is reduced to the point where most of these systems have a service life of approximately two years. Total cost of magnesium systems of this type varies from approximately $800 to $1600 per year, depending upon the total submerged surface area involved. These figures include material, installation, and maintenance cost.

In an attempt to increase the efficiency of magnesium anodes by locating them where they will be subjected to a minimum amount of agitation by the natural movement of sea water, a different design of the magnesium-anode systems has been recently utilized on well platforms. This design, which is shown in Fig. 1, involves placing strings of magnesium anodes on the ocean floor at a distance of approximately 20 ft outside the structure. Each anode string is made up of four 100-lb magnesium anodes, spaced approximately 10 ft apart, and is connected to the platform with a No. 2, twisted wire insulated, copper cable.

Acknowledgment

Writers express their appreciation and thanks to the management of Magnolia Petroleum Company, Continental Oil Company, and Newmont Oil Company for permission to publish this paper.

Presented at the spring meeting of the Southern district, American Petroleum Institute, Division of Production, in Shreveport, Louisiana, March 20-21, 1957, under the title: "Cathodic Protection of Offshore Structures and Submerged Piping Systems in the Gulf of Mexico."

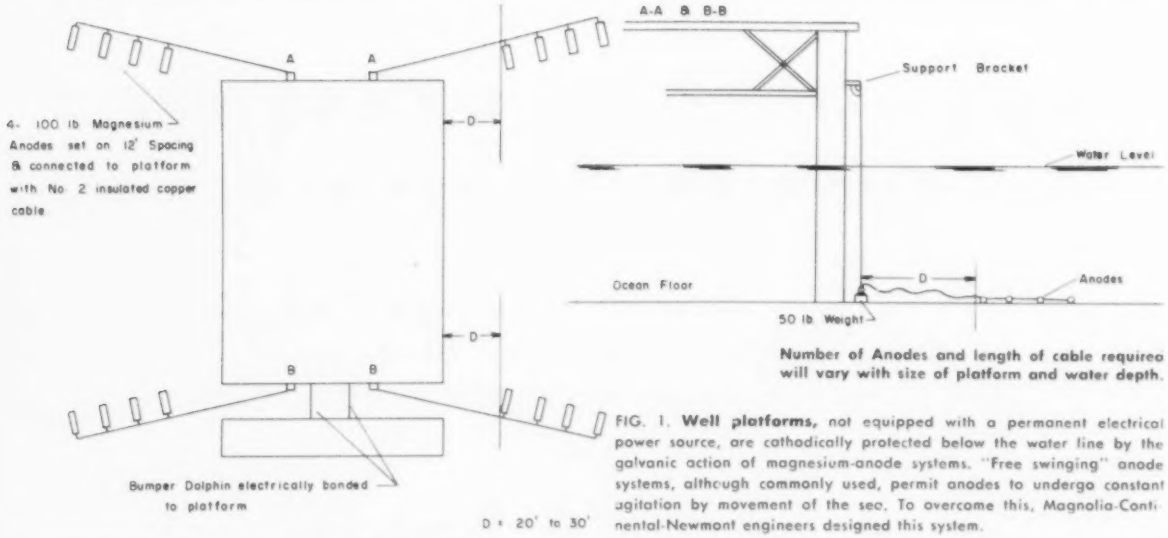

A-A & B-B
Support Bracket
Water Level
Ocean Floor
Anodes
50 lb. Weight
4- 100 lb. Magnesium Anodes set on 12' Spacing & connected to platform with No. 2 insulated copper cable
A
A
B
B
D
Bumper Dolphin electrically bonded to platform
D = 20' to 30'
Number of Anodes and length of cable required will vary with size of platform and water depth.

FIG. 1. **Well platforms,** not equipped with a permanent electrical power source, are cathodically protected below the water line by the galvanic action of magnesium-anode systems. "Free swinging" anode systems, although commonly used, permit anodes to undergo constant agitation by movement of the sea. To overcome this, Magnolia-Continental-Newmont engineers designed this system.

Danger of small boats becoming entangled in the anode lead wires is greatly minimized by anchoring these wires to the ocean floor by means of a 50-lb weight as shown in Fig. 1.

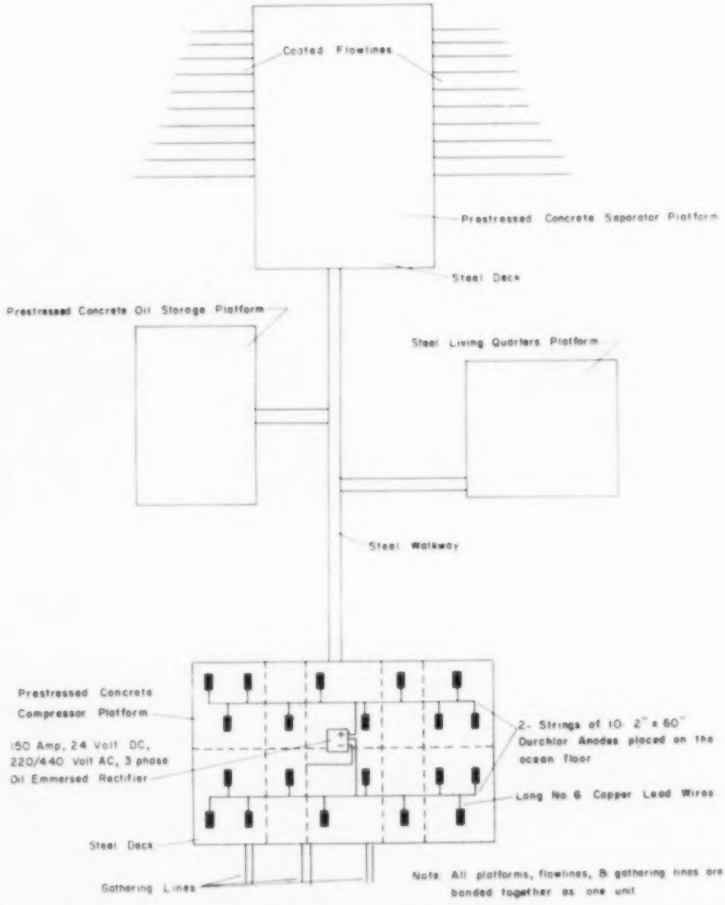
Results obtained from this type system have been highly satisfactory in that protective structure-to-water potentials, measured with repect to a saturated calomel half-cell, of from –0.80 to –0.92 v were attained on the structures involved. Initial current output from each anode string was approximately 14 amp. However, this current output decreased to approximately 9 amp per string as polarization of the platforms occurred. Based on the latter current output and considering a conservative anode efficiency of 50 percent because of reduced anode agitation, this type system should have a useful service of at least three years.

Most of the work involved in installing this type system was performed either on shore or from a boat, which reduced the effort and boat time to about one-third the time required to install the previously described free-swinging anode systems. Because of the reduced installation cost and the possible increase in anode life, it is believed that the total cost of this type system will vary from approximately $500 to $1000 per year, depending upon the total submerged surface area.

Central Separator Platforms and Flowlines

Magnolia-Continental-Newmont located central separator facilities in two offshore oil fields — the Eugene Island Block 126 field and the Eugene Island Block 128 field. These facilities are connected to the wells of their respec-

Design of the Cathodic Protection System and the Layout of the Block 126 Central Separator Group


Coated Flowlines
Prestressed Concrete Separator Platform
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Prestressed Concrete Oil Storage Platform
Steel Living Quarters Platform
Steel Walkway
Prestressed Concrete Compressor Platform
150 Amp, 24 Volt DC, 220/440 Volt AC, 3 phase Oil Emmersed Rectifier
2- Strings of 10- 2" x 60" Durchlor Anodes placed on the ocean floor
Long No. 6 Copper Lead Wires
Steel Deck
Gathering Lines
Note: All platforms, flowlines, & gathering lines are bonded together as one unit

FIG. 2. **Ground bed failure,** because of excessive wave action, prompted operators to initiate a new anode system at the Block 126 central separator group. This called for installation of twenty 2 by 60-in. silicon-iron anodes equipped with 60 ft lead wires. Individual placing allowed 3 to 5 ft of slack to be left in the lead wires.

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tive fields by means of submerged flowlines. Also, two separator facilities are interconnected to an onshore plant and terminal by means of a two-phase gathering line. Both of these central separator facilities and the onshore terminal are equipped with permanent electrical power that permits use of impressed-current cathodic protection systems. The installation required for cathodic protection of these facilities and their associated submerged piping equipment are described in detail following.

Eugene Island Block 126 central separator platforms and associated submerged piping systems. Eugene Island separator group is made up of a series of flowlines connected to a group of 4 platforms. This group of platforms is interconnected by steel walkways and is composed of 1 steel structure and 3 prestressed concrete structures. Steel bracing on the prestressed concrete structures is coated with gunite. Flowlines which connect wells of the Block 126 field to the separator group are insulated from both the wells and well platforms by insulating flanges. These flowlines are coated with a standard coal tar and felt coating. Also, the 20 miles of 12-in. OD gathering line, which is electrically tied into this system, is coated with coal tar, felt and cement. Central separator platforms, flowlines, and gathering lines are all bonded together electrically as one unit.

Exposed steel surface area of this operator group and its associated piping was generously estimated to be approximately 40,000 sq ft with at least 10,000 sq ft located on exposed platform members. Based on this estimated value of exposed surface area and the belief that cathodic current densities of 2 to 5 milliamperes per sq ft will provide adequate protection of steel in sea water, a ground bed and rectifier with a 24-v, 150-amp output, was installed on one of the prestressed concrete structures as shown in Fig. 2. Original ground bed was composed of twenty 2 in. by 60 in. silicon-iron (Duriron) and twelve 3 by 60 in. graphite anodes. These anodes were individually supported by their lead wires and permitted to swing free at a water depth of about 20 ft. After approximately 10 months of service, however, this ground bed failed because excessive wave action had broken most of the anodes loose from their lead wires. In order to minimize the possibility of recurrence of this problem, a new anode system, composed of twenty 2 by 60 in. silicon-iron anodes equipped with 60-ft lead wires, was installed in place of the original system. The long lead wires permitted the anodes to be individually placed on the ocean floor with 3 to 5 ft of slack left in the lead wires. Possibility of an anode becoming electrically shorted to the platform is eliminated because all submerged steel in this structure is coated with concrete or gunite.

Close proximity (100 ft) of the ground bed to a platform with a large exposed steel surface area presented an unknown factor as to the ability of this installation to protect the steel structure together with the wide expanse of submerged piping. However, because of the excellent quality of the pipe coatings and ability of a steel surface to polarize in sea water, a protective pipe-to-water potential ranging from –0.82 to –0.96 v, as measured with respect to a saturated calomel half-cell, was soon obtained throughout the entire system.

It is believed that this system will have a service life of 10 to 15 years. The total cost of material, installation, and repair of this system has amounted to approximately $4500. It is estimated that the cost of power required to operate this system will not exceed $50 per year. Based on a 10-year service life, total cost of providing cathodic protection for the Block 126 central separator group and its associated submerged piping equipment should be about $500 per year.

Eugene Island Block 128 central separator platforms and associated submerged piping equipment. Platforms of the central separator group were set and submerged piping installed during the late summer and fall of 1956. These platforms, which are constructed of prestressed concrete and steel piling with exposed steel bracing, are interconnected with steel walkways. Flowlines, which connect the wells of the Block 128 field to the separator group, are coated with a standard coal-tar and felt coating. This same coating will be applied to additional flowlines which will be installed in the near future. Gathering line connecting this group to the Eugene Island Block 126 central separator facility is coated with

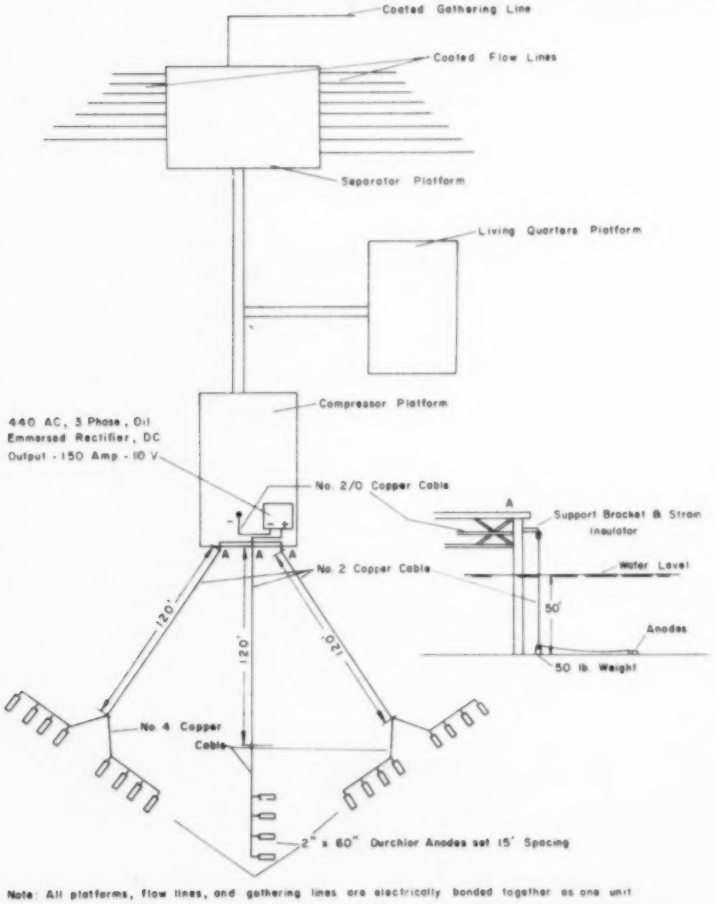
Coated Gathering Line
Coated Flow Lines
Separator Platform
Living Quarters Platform
Compressor Platform
440 AC, 3 Phase, Oil Emmersed Rectifier, DC Output - 150 Amp - 10 V
No. 2/0 Copper Cable
Support Bracket & Strain Insulator
Water Level
No. 2 Copper Cable
50'
Anodes
50 lb. Weight
120'
120'
120'
No. 4 Copper Cable
2" x 60" Durchlor Anodes set 15' Spacing
Note: All platforms, flow lines, and gathering lines are electrically bonded together as one unit

FIG. 3. **Total exposed area** of 40,000 sq ft is protected by this central ground-bed arrangement used at the Block 128 central separator group. Bed consists of twenty 2 by 60-in. silicon-iron anodes spaced 15 ft apart. The system is designed to give 10 or more years of service before failure.

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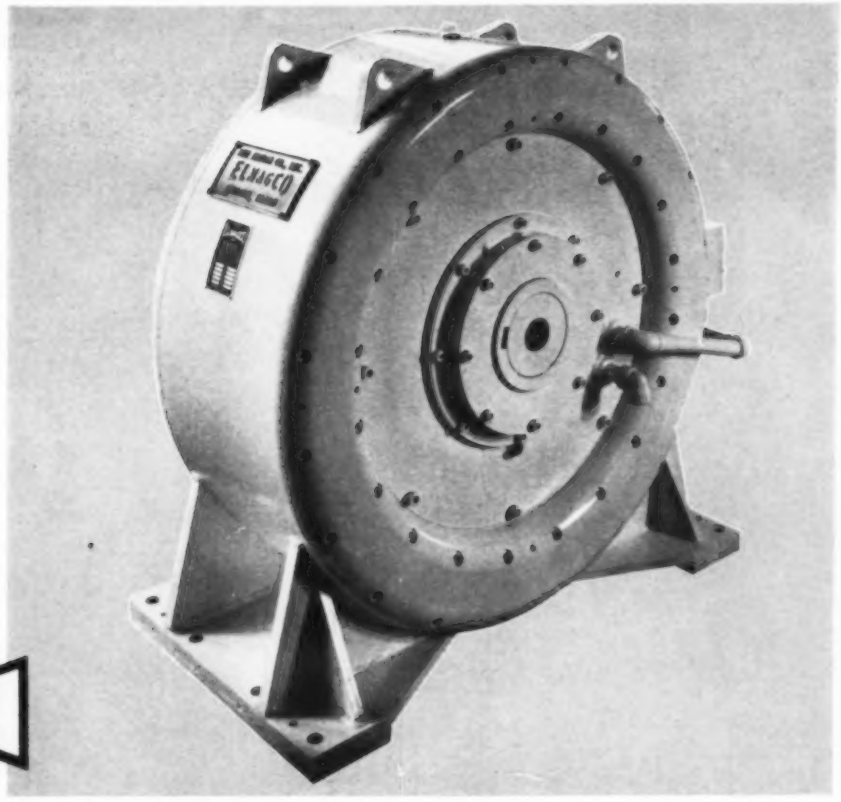

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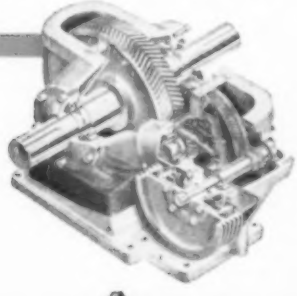
Repeat operation until weights are swung into the desired position. When weights are pivoted as far as possible maximum counterbalance effect is obtained. Adjustment markers are provided to facilitate operation.



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coal tar, felt, and cement. Flowlines are electrically insulated from the wells and well platforms by insulating flanges, and the gathering line is electrically insulated from the Block 126 group with an insulated flange located at the 126 structure. Central separator platforms, flowlines, and 10½ in. line are all bonded together electrically as one unit.

Surface area of the submerged bracing is approximately 20,000 sq ft, and the ultimate exposed surface area of the piping equipment was estimated to be approximately 20,000 sq ft. Therefore, a total exposed surface area of 40,000 sq ft was used as a basis for the design of this cathodic protection system. The design, together with the platform layout, is shown in Fig. 3. It was decided that a 10-v, 150-amp rectifier would be adequate to handle the cathodic protection needs of this group. In conjunction with this rectifier, a ground bed was placed on the ocean floor approximately 100 ft from the nearest platform. The ground bed consists of twenty 2 by 60 in., silicon-iron anodes spaced 15 ft apart and arranged as shown in Fig. 3.

Ability of this central ground-bed arrangement to protect exposed steel bracing of the platforms as well as the entire piping arrangement is still an unknown factor. Based on the experience gained from the Block 126 central separator group, however, and because of the excellent quality of the pipe coatings, it is believed that the protective potential field created by this cathodic protection unit will soon be extended over the entire piping system.

This cathodic protection unit was designed to give 10 or more years of service before failure. Total cost of materials and installation amounted to approximately $2500. Power cost to operate this unit should not exceed $50 per year. Based on a 10-year life of the cathodic protection system, total cost of protection of this central separator facility and its associated piping equipment should be approximately $300 per year.

Offshore gathering-line system. Gathering-line system extending from an onshore terminal and plant to offshore gathering points is shown in Fig. 4. This system is composed of 48 miles of 12-in. OD gathering line and 18 miles of 10½-in. OD gathering line. These lines are coated with coal tar, felt, and cement; however, the coating on the 8 miles of 10½-in. OD line connecting platform 51-B to 95-C was severely damaged during installation. Because of this damaged coating, this line was put under cathodic protection with magnesium anodes placed at 2000 ft intervals at the time the line was laid. The balance of the gathering system is under cathodic protection — as shown by the potential distribution in Fig. 4 — from the impressed current systems located at the Burns plant, Block 126 central separator, and the Block 128 central separator. Platforms 51-B, 95-C, and the juncture platform shown in Fig. 4, are equipped with magnesium anode systems.

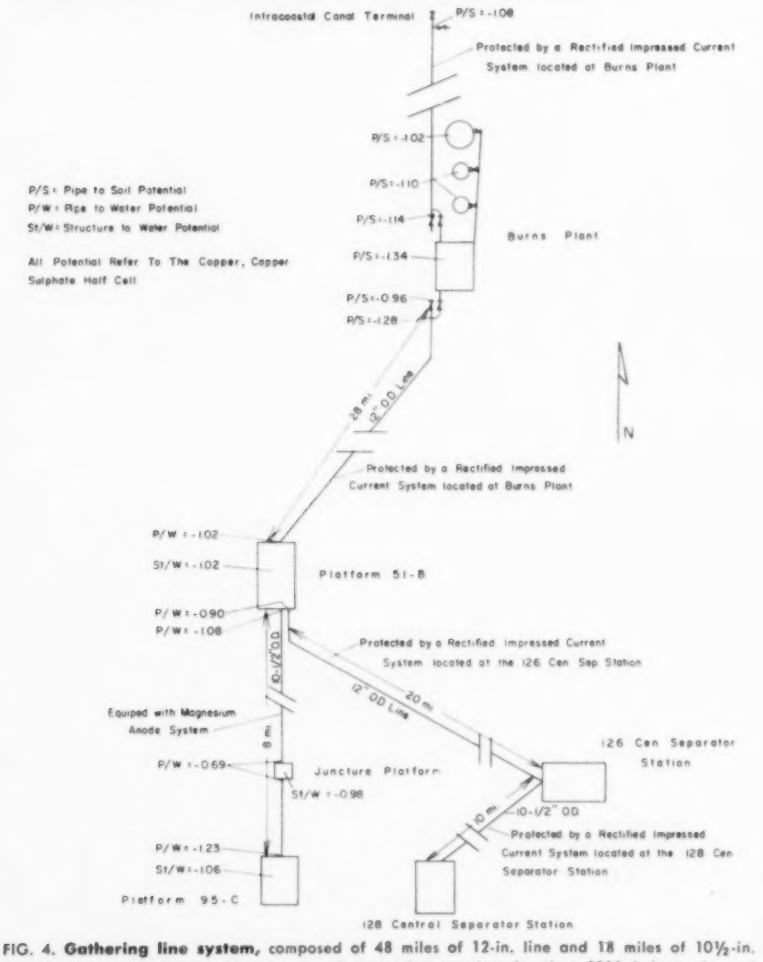
Intracoastal Canal Terminal
P/S = -1.08
Protected by a Rectified Impressed Current System located at Burns Plant
P/S = -1.02
P/S = -1.10
P/S = -1.14
P/S = -1.34
P/S = -0.96
P/S = -1.28
P/S = Pipe to Soil Potential
P/W = Pipe to Water Potential
St/W = Structure to Water Potential
All Potential Refer To The Copper, Copper Sulphate Half Cell
Burns Plant
28 mi. 12" OD Line
N
Protected by a Rectified Impressed Current System located at Burns Plant
P/W = -1.02
St/W = -1.02
Platform 51-B
P/W = -0.90
P/W = -1.08
10-1/2" OD
Protected by a Rectified Impressed Current System located at the 126 Cen Sep Station
12" OD Line
20 mi.
Equiped with Magnesium Anode System
126 Cen Separator Station
P/W = -0.69
Juncture Platform
St/W = -0.98
10 mi.
10-1/2" OD
Protected by a Rectified Impressed Current System located at the 128 Cen Separator Station
P/W = -1.23
St/W = -1.06
Platform 95-C
128 Central Separator Station

FIG. 4. **Gathering line system,** composed of 48 miles of 12-in. line and 18 miles of 10½-in. line, is given cathodic protection by use of magnesium anodes placed at 2000 ft intervals, and by impressed current system located at the Burns plant, Block 126 central separator, and the Block 128 central separator. Platforms 51-B and 96-C and juncture platform are equipped with magnesium anode systems.

Conclusion

Problem of cathodic protection of offshore platforms and submerged piping equipment can be solved with a very nominal annual cost per unit. Annual cost of a magnesium anode system is slightly more than the annual cost of an equivalent impressed current system because of its relatively short service life. In many cases, however, there is no permanent electrical power supply available on well platforms. Therefore, in this case the magnesium-anode system is the most economical solution to the cathodic protection problem.

We have demonstrated that fairly long segments of well-coated offshore gathering lines, flowlines, and relatively large bare steel structures can be electrically bonded together as one unit and economically protected by an impressed current system utilizing a central ground bed located near the bare steel structures. It is believed, however, that this approach would not be economically feasible in locations where bare steel structures were very large or pipe coatings were in poor condition. In these cases the development of large protective potential fields, such as has been achieved from central ground beds would be exceedingly difficult. This difficulty arises from the inability of the polarization phenomenon to create such a potential field in sea water without the aid of highly-resistant pipe coatings. ★ ★ ★

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To get the full story on the improved TOP Packer, check H-1 on the attached card.

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KWIK-KONE GIVES FASTER, TAILOR-MADE SHOOTING OPPOSITE LONG ZONES

Another new development in Lane-Wells Koneshot ® perforating makes it possible for the operator to shoot an extremely long zone, with a wide choice of shot spacing, on a single run. This is Kwik-Kone, an assembly of powerful Koneshot charges in aluminum containers mounted in a flat steel carrier. After the Kwik-Kone is fired, the steel carrier retrieves from the well in the same manner as the conventional round carrier.

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Lane-Wells shooting crews have long held the reputation of getting perforating jobs done with a minimum of rig time. The Kwik-Kone enables them to shoot the longest zones with made-to-measure shot patterns and spacing with the fewest possible number of runs. In fact, most jobs can be shot on one Kwik-Kone run.

With all of their speed, the Kwik-Kone guns are of a type which achieve deep, clean penetration, and high productivity. Furthermore, they are the only ones of their type that give the operator a positive index of having been fired.

The Kwik-Kone is available in two sizes: one which will pass through a 3¼" I.D. ring; and the other which will pass through a 4¼" I.D. ring. For more information on this latest Lane-Wells Koneshot convenience, check **H-2** on the attached card.

TANDEM E-GUN MULTIPLIES SUNDAY PUNCH

The mighty Lane-Wells E-Gun can now run as twins, or triplets, to give the operator 50 or 75 of the deepest bullet perforations obtainable, all on one run. Already famous as a premium-performance gun for reaching way into tough formations through multiple casing strings, the E-Gun can now accomplish mass shooting on one run with minimum rig time.

And the E-Gun's versatility has been increased with tandem shooting, too. The selective firing offered with the E-Gun permits you to shoot one zone from one gun section with as many as 6 shots per foot; shoot another zone with a different shot density; blast one zone with all three gun sections; or shoot practically any combination you choose to do the job – all on one run in the hole. As a matter of fact, you can shoot 75 shots in one foot, one shot every 75 feet or any place in between – you call the shots and Lane-Wells crews will put 'em where you want 'em. And never fear about accuracy – those shots will be precisely where you want them in exactly the shot density you order. That's a fact.

Ready for use in all fields, the E-Gun in tandem has been tried with outstanding success in the Rocky Mountain area, West Texas, the San Juan Basin, and the Pacific Coast. Most of the jobs in these districts were completed on one run, thus saving hours of rig time.

E-Gun perforations have proved particularly effective in obtaining production from tight or mudded-off formations. Its powerfully propelled bullets develop a radial shattering effect which increases the area of drainage over that which could be expected from

ABSTRACTS

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SHAKY TOOL PROVIDES USEFUL DATA — A modern improvement on one of the oldest geological tools, the sieve, separates mineral content in unconsolidated and prepared sediments and provides invaluable aid in determining porosity and permeability, grain size, mineral concentration, and micro-faunal concentration. **H-3**

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R/A LOGS GIVE AMPLE DATA ON GAS-DRILLED WELLS Because electrical logs cannot be run in gas-drilled wells, Radioactivity logs must be relied upon to provide the necessary downhole data. A method has been worked out whereby interpretation of Radioactivity logs in San Juan Basin wells will yield essential data on lithology, porosity, and fluid content. **H-5**

JET PERFORATING WITHOUT JET DEBRIS — The new Karrotfree Koneshot perforating guns retain the carrot, a jet-perforating by-product, within the gun. The resulting holes in the formation, being free from blocking material, yield higher production. **H-6**

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ICE DRILLING MAY REVEAL WEATHER SECRETS — Oil industry-type core drills are being used by U.S. Army engineers to tap literally the weather secrets frozen in the mile-thick Greenland ice cap. "Production" will consist of data on temperature, weather cycles over the past thousand years, wind currents, and the effect of the ice cap on world climate. **H-7**

penetration alone. Its depth of penetration reaches the oil beyond the mudded-off or watered-off area in the vicinity of the hole. Now that the E-Gun can be run in multiples, more than ever before can it be said that "the E-Gun gives your well its best chance to produce."

Originally designed for the unusually tough perforating job, the E-Gun has proved so effective in producing oil that many operators are using this premium tool on more-or-less routine completion jobs. They figure that the extra production makes the investment well worth while. These boys, mighty sharp with a pencil, will now find that the reduced rig time with the tandem run, will make the use of the E-Gun more attractive than ever.

Check **H-8** on the attached card for more information on this tandem perforator.

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The Densilog provides information not available with any other type of logging instrument. Its readings provide the geologist and engineer with invaluable data with which to correlate formations and develop production programs.

The Densilog, run from standard Lane-Wells radioactivity logging trucks, bombards the formation with gamma rays emitted by a device held tightly against the wall of the open hole. An amount of gamma radiation inversely proportional to the density of the rock so bombarded is picked up by a detector and is recorded on a log at the surface. Since density of the rock is inversely proportional to the porosity, these density readings can readily be interpreted in terms of porosity.

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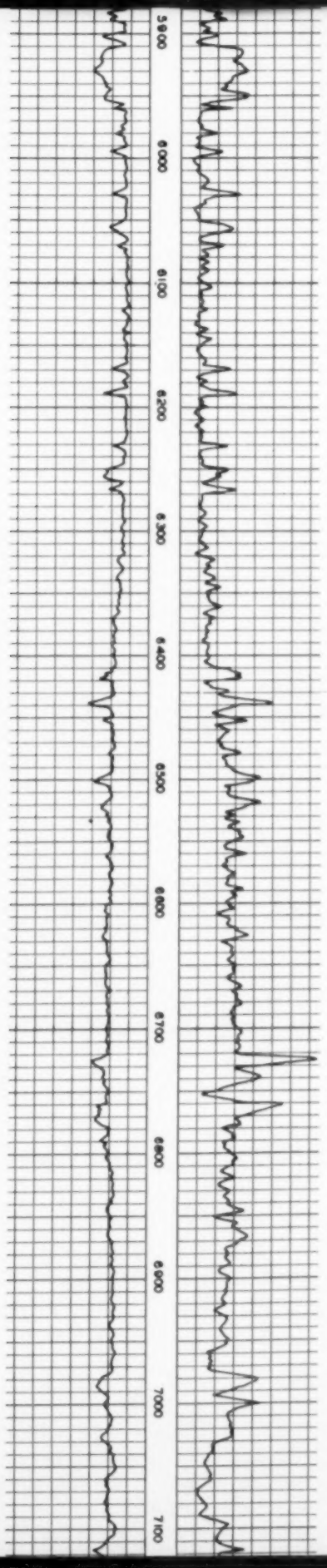

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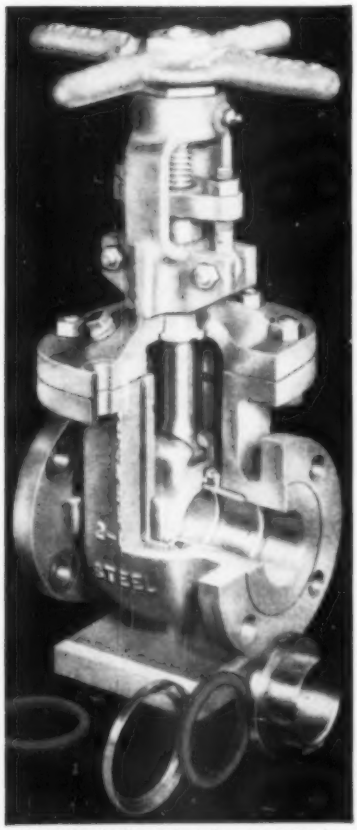

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Humble Oil and Refining Company

USE of reduced diameter casing and the size of the other equipment required to produce an oil or gas well has resulted in proving that it is a practical means of reducing well costs both for exploratory and development drilling. As of 1957, Humble Oil and Refining Company had drilled a total of 304 wells since the start of the program in which reduced casing sizes were employed and ranged in depth from 1225 to 10,824 ft. The 304 wells consisted of 241 producing oil or gas wells, 44 dry holes, and 19 waterflood wells. Production casing size used varied from 3½-in. OD to 5-in. OD pipe.

Cost of wells drilled since inauguration of the program average 14 percent less than regular size wells. Savings result from the use of smaller rigs and less material. Careful design of the hydraulic system is a necessary aid in making drilling rates competitive with those in wells where so-called conventional equipment, hole size and casing programs are employed. Humble's reduced hole size and casing program is expanding generally.

Slim-Hole Story

A continued increase in drilling costs due to greater material and rig operating expenses coupled with greater well depths has caused a search for any means of counteracting costs increases. Admirable results have been attained in reduction of drilling time by improved methods and equipment. In pursuing further the problem of reducing costs, the possibility of reducing hole size sufficiently to allow use of smaller rigs and well equipment in relatively deep drilling appeared to offer promise.

Mud pumps are now capable of operating at the pressures required by high pressure losses in smaller holes and drill pipe, improvements in the control of mud properties, and development of well completion techniques applicable to smaller casing sizes are being made. These developments have caused the use of a reduced hole and casing size program to seem more likely to meet with success than when initially tried in the late 1930's. Consequently, Humble reconsidered such a program in the early 1950's which at the outset consisted of a study of previous and current operations prior to the decision to drill. Limited drilling at this time by other operators was confined to exploratory tests with no intention of setting small diameter production casing. Should a producing zone be found, either the small hole would be reamed or an adjacent regular size well drilled to accomodate accepted standard diameter casing.

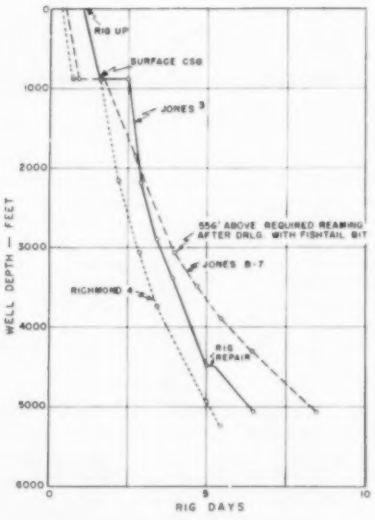

FIG. 1. **Comparative drilling time** to total depth for Humble wells J. H. Jones No. 3, a 7⅞-in. hole, the J. H. Jones B-7, and Fred Richmond No. 4, small holes in the Imogene district, Southwest Texas division.

Since it was evident that maximum reductions in well cost would be effected by drilling and completing wells in producing areas as well as for exploratory drilling.

Small Hole Beginning

Humble's first well as a result of the current study was drilled and completed as a producer in the Danbury field, Texas, starting in October 1953. A 4¾-in. hole was drilled to 5800 ft below 8⅝-in. surface casing set at 1375 ft. The drill string consisted of 2⅞-in. OD N-80 upset tubing and 3¾-in. OD drill collars in the 4¾-in. hole; the tubing was fitted with tool joints. A jackknife power rig was used. Drilling rate was relatively slow due to limited bit weight carried because of concern over hole deviation which actually proved a minor problem, and due to inadequate bits being available at that time in the 4¾-in. size. Unsuccessful experimentation was carried on with various types of bits other than the 3-cone rock bits used for most of the drilling. Total hours rotated were 318 compared with 200 for an adjacent 7⅝-in. well. The 4¾-in. hole was induction logged and sidewall cores were taken; 4-in. OD flush joint casing was cemented at 5711 ft with rather high circulating pressures due to the small annular clearance. Well was completed as a flowing oil well in 29.7 days compared with 20.9 days for

Presented at the North Texas Oil and Gas Association, March 30, 1957, in Wichita Falls, Texas, under the title "Application of Small-Diameter Casing for Oil and Gas Wells.

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a large size well. Despite the longer drill-and-complete time and experimentation expense, total cost for the 4¾-in. well was slightly less than for a regular well.

A second adjacent well, 5⅝-in. hole, was immediately drilled and completed with 4-in. OD threaded and coupled in 26.5 days with the same rig at a cost 15 percent less than for a regular size well. In addition to a reduction in tool rental charges, casing cost was less, and improved performance was obtained from bits which were available in the 5⅝-in. size. In view of these encouraging results, 15,000 ft of 2⅞-in. N-80 drill tubing was purchased equipped with welded-on tool joints, for use in drilling 6⅛-in. or smaller holes.

Immediate Savings

The next wells were drilled under the program in the Southwest Texas, Pruitt field, beginning in March 1954; well depth was slightly greater than 5000 ft. The first two were 5⅝-in. holes drilled below 7-in. surface casing while subsequent wells were 6⅛-in. holes drilled below similar surface pipe, a total of 23 such wells were being drilled in the area during 1954, and 69 as of the end of 1956, including 6 dry holes. A saving of 13 percent per well was indicated in well cost compared with regular wells. Comparative drilling time curves for two wells having reduced hole and casing sizes and one regular size well at Pruitt are shown in Fig. 1. Drilling rates were increased, as indicated by curves for the second and seventh wells drilled, when it was found possible to carry weights of from 14,000 to 15,000 lb on the small bits with rotary speed over 130 rpm as much as 13,000 lb was carried on 6⅛-in. fishtail bits without detriment to the 2⅞-in. EUE N-80 drill tubing. Actual penetration rates became quite comparable to those for regular holes. Four-inch and 4½-in. OD threaded and coupled casing was set in the 5⅝-in. and 6⅛-in. holes, respectively, as oil strings. A small rig has been used in drilling these wells.

Deep Wells in Program

Practice of using smaller casing and a reduced hole size was begun in other Texas areas, and by the end of 1954 a total of 40 wells had been drilled by contract rigs most of which were jackknife or trailer rigs. A total estimated savings of 13 percent was effected in these wells compared with large holes. For one 12,260-ft well deepened from 6384 ft on a reduced hole size and casing program basis, a saving of 39 percent was indicated due in part to reduced size of protective casing an elimination of hole reaming.

Revision of hole size and casing programs has shown continued expansion with resultant savings in well costs keeping pace. The number of wells drilled of this category and total savings have more than doubled from year to year, and the 187 wells drilled in 1956 represent 20.6 percent of the total wells drilled by Humble during the year with a 15 percent savings.

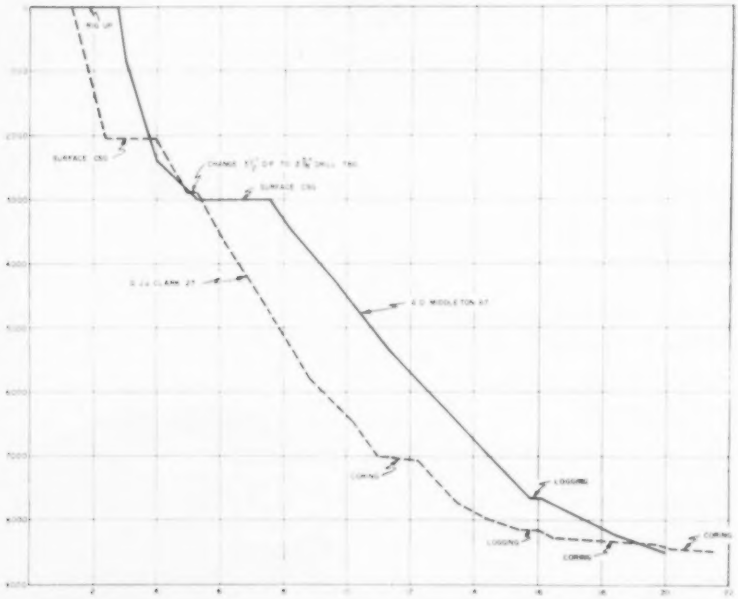

FIG. 2. **Comparative drilling time** for two Humble wells in the Anahuac district, Gulf Coast division. Wells are the A. D. Middleton No. 67, an 8⅝-in. hole and the G. J. J. Clark No. 27, a 6⅛-in. hole.

Hole Sizes

Hole size considered in this analysis ranges up to 6¾-in. and areas where it has been the practice in the past to drill the 6¾-in. holes on a routine basis are not considered. Production casing up to 5-in. OD has been used. Wells have been drilled deeper than 10,500 ft, one well having been completed as a dual oil well with 5-in. OD casing set at 10,599 ft after drilling 6¾-in. hole to 10,647 ft. For the 6¾-in. holes 3½ or 4-in. drill pipe has been used.

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One of the deepest wells of the catagory mentioned, drilled with a light portable rig was a 6⅛-in. hole drilled to 8489 ft at Anahuac in the Texas Gulf Coast in 1956. The light portable rig had a 103-ft, 150,000-lb capacity mast and 380 maximum horsepower on the drawworks. The well was completed as an oil well with 4½-in. casing at total depth. Fig. 2 shows comparative drilling time between the 6⅛-in. hole and an 8⅝-in. adjacent hole drilled by a heavy steam rig. The curves indicated that the light rig rigged-up in half the time for the heavy rig and that drilling time was comparable. The 6⅛-in. hole was drilled using 2⅞-in. N-80 drill tubing weighing 6.8 lb per ft. Due to the lower rig operating and casing costs, the well was drilled and completed for a 12 percent reduction.

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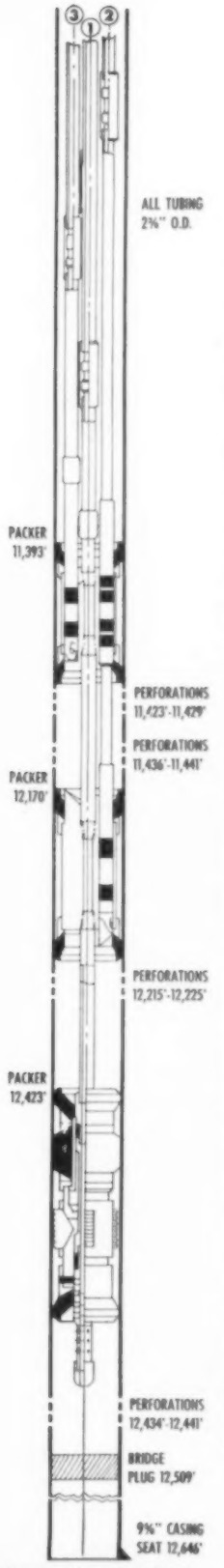
America's "first" triple-completion well
depends on NATIONAL SEAMLESS STEEL TUBING



Schematic of Triple Completion

•About five miles northeast of St. Martinsville, Louisiana, stands the country's most unique Christmas tree—that of *America's first* hi;h-pressure, triple-completion well. This single Christmas tree tops off three strings of tubing to permit simultaneous, but separate, production from three different zones.

Owned by Aluminum Company of America, Mining Division, the triple well serves the same purpose as three singles, at a fraction of the cost.

The well is bottomed at 12,646 feet, where 9⅝-in. National Seamless Casing was set. Oil, rated at between 40 b/d and 60 b/d of 35.4 gravity, is produced from two perforation intervals in the top zone—11,423-29 ft. and 11,436-41 ft. Gas is produced from the second and bottom zones—12,215-25 ft. and 12,434-41 ft., respectively.

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National Seamless Oil Country Tubular Products are habitually chosen when the job has to be done "just right." No matter how rigorous the conditions, National Seamless products promise trouble-free dependability. The seamless process of manufacture gives them unsurpassed uniformity and strength, the best defense against high pressures, vibration, fatigue, twisting action, and collapse.

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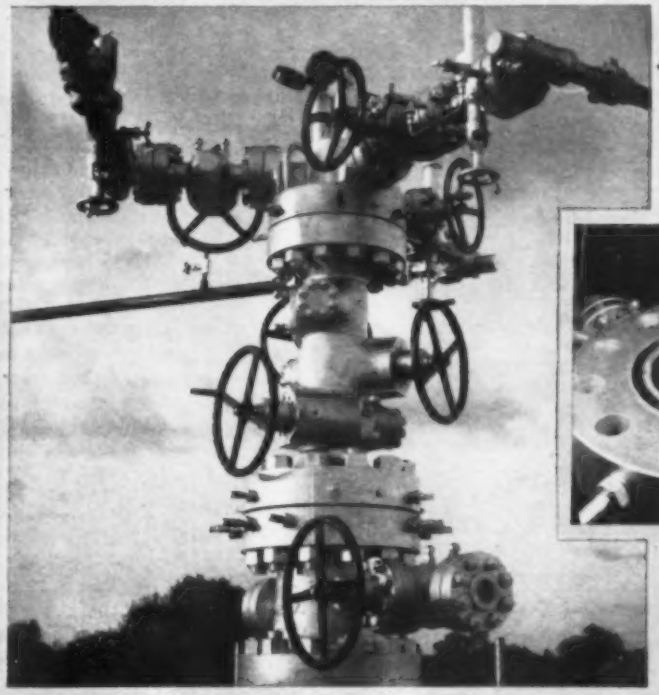
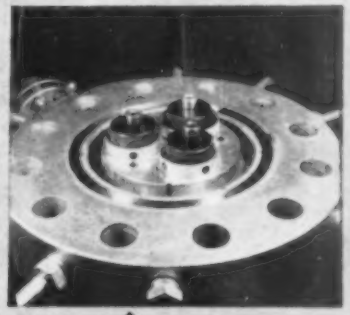


Three flow lines off Christmas tree permit separate production of gas and oil from three different zones.



Three strings of tubing show at top of head spool.

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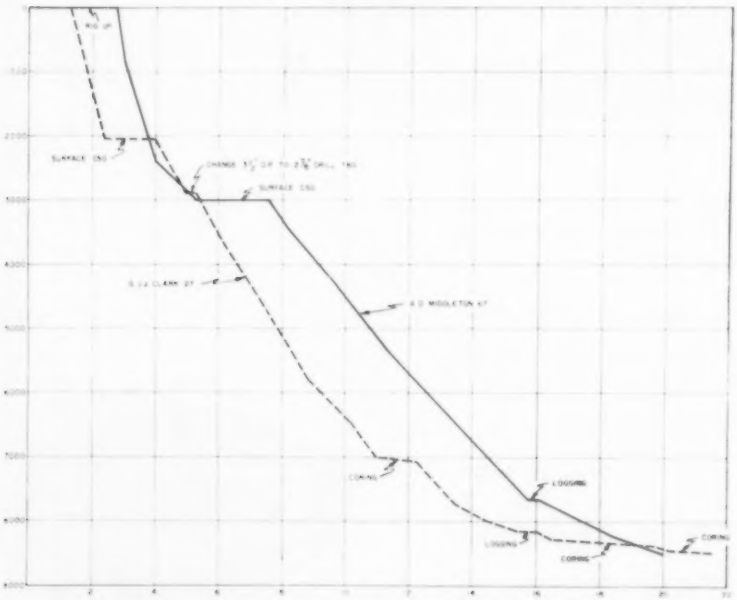

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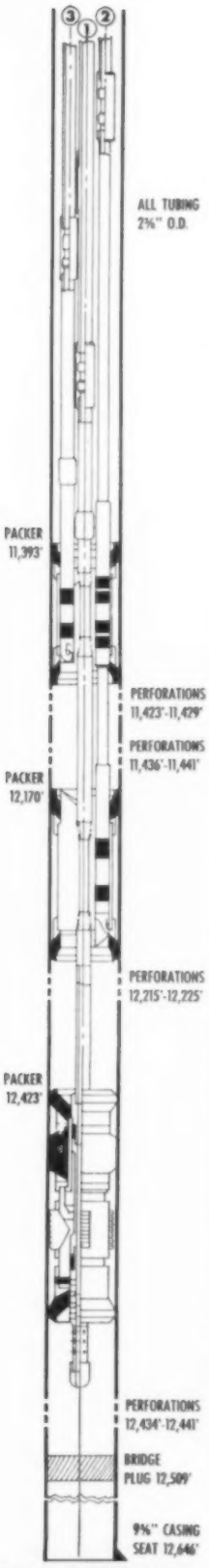

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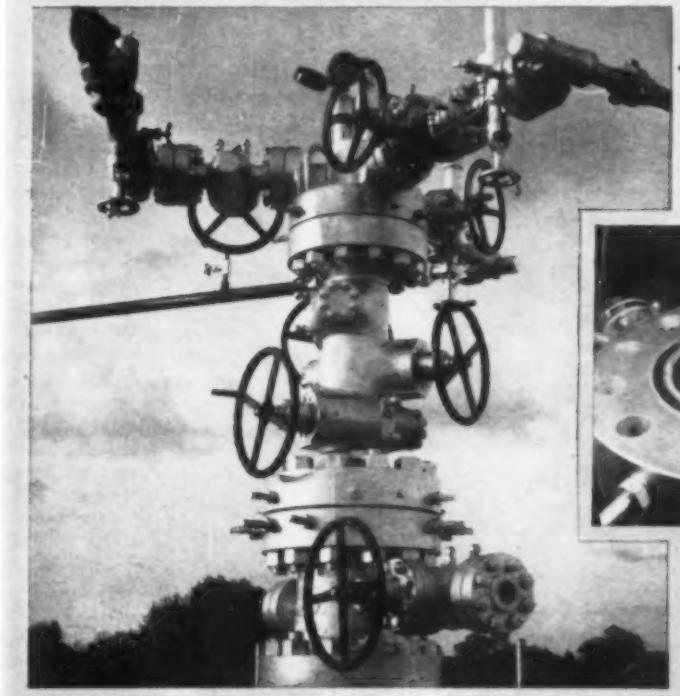

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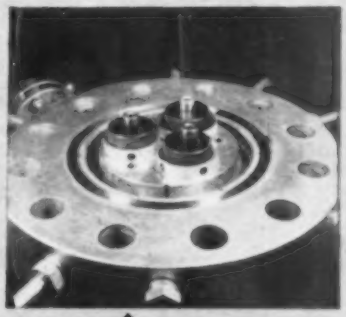

Three strings of tubing show at top of head spool.

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ment over previous designs of that size. Nozzle sizes used were ¼-in. Well was drilled and completed without complication in 13.7 days. It is felt that faster penetration rates and more footage per bit could have been obtained had maximum bit weight not been limited to 8000 lb; length of the drill collar string was held to 300 ft because of fear of losing returns in a 3400-ft zone due to back pressure on the formation caused by close clearance. A 6⅛-in. offset well drilled with 16 percent greater bit weight per inch showed a 21 percent faster penetration rate. Seven bits were used in drilling 4640 ft of 4¾-in. hole against 5 bits for drilling 4300 ft of hole in the 6⅛-in. well. No hole deviation trouble was experienced. Fig. 3 shows comparative drilling time for the 4¾-in. well and 6⅛ and 8⅝-in. wells drilled in the field. Although 2 days more were required in drilling the 4¾-in. hole, total well cost was 8.2 percent less than for a 6⅛-in. well with 4½-in. casing or 34.6 percent less than for an 8⅝-in. well with 5½-in. casing.

At total depth electric and micrologs were run, and 6 sidewall cores were taken in the 4¾-in. hole. A 3-core sampler was run twice to obtain the 6 cores; in this way, the samples hung below the tool body when coming out of the hole providing additional clearance. A 3½-in. OD oil string was set at 5668 ft with 80 ft of 5-in. OD casing on top for kelly clearance, and a stage cementing tool at 2551 ft. Five centralizers were run on the 3½-in. pipe. After drilling out the stage tool plugs with a 2¾-in. mill on 1.9-in. OD tubing, gamma ray and neutron logs were obtained, and the tubing was rerun and set at 5266 ft with a joint of 2-in. EUE tubing on top to connect to the 2-in. Christmas tree. Casing was perforated with 29 shots from 5572 to 5578 ft for production. Well was completed as a flowing oil well.

In the North Texas area during 1955 and 1956, a total of 54 wells have been drilled by Humble of 6¾-in. size, 4½-in. casing being set when producing wells were made. Depths ranged from 1835 to 7700 ft. Although the same rigs were used in most cases that would have drilled larger holes, a saving in well costs was effected by a reduction in expenditures for casing and cement. Improved rock bits have been used to advantage in the small holes and it is felt that with bits now available, hole size can be further reduced with gains in penetration rates due to application of available pump horsepower to drilling the smaller diameter hole. The 3½-in. OD drill pipe and 4¾-in. drill collars now often used with 6¾-in. hole could also be employed in drilling 6⅛-in. wells.

Bit Performance and Design

Progress in drilling small holes has been aided by improvement in rock bits in 6¾-in. and smaller sizes. These include bit construction and longer cut or teeth for soft drilling. Bearing design has also been improved especially in the 4¾-in. range. Good runs with small diamond bits in Southwest Texas make their use appear promising in relatively hard deep drilling.

Concerning nozzle diameters, both 13/32 and ⅜-in. nozzles have been used to advantage in 6¾ and 6⅛-in. bits. In certain areas, rock bit failures have resulted while drilling shallow sections due to sand erosion of the bit bodies and insert snap rings. Experience indicates that complete erosion failures are most likely to occur in these bits at pumping rates greater than 250 gpm and that failures can be reduced by the use of ⅜ in. or smaller bit nozzles and reduced circulating rates under erosive conditions; drilling efficiency is to a great extent maintained by the increased nozzle velocity.

Drill Tubing Selection

It is found that 2⅞-in. N-80 tubing equipped with 3⅞ or 4⅛-in. OD welded on tool joints has been very satisfactory in drilling 6⅛-in. holes to depths as great as 7350 ft. A 5500 ft string of this pipe drilled over 150,000 ft of hole. The tool joints are hard banded. Although this pipe has been used in drilling shallow 6¾-in. holes, hydraulics indicate that 3½-in. drill tubing with 4⅝-in. tool joints should be used so as to reduce pressure losses in drilling 6¾-in. holes of any depth and 6⅛-in. holes below medium depth. A reduction in hole size to 5⅝ or 4¾-in. would make efficient use possible of the 2⅞-in. tubing with welded on tool joints in deeper drilling. High yield strength tubing should be quite adaptable for drilling.

Drill Collar Application

It is now general practice in Texas Gulf Coast areas to use 4¾-in. and 5¼-in. drill collars, respectively, in 6⅛-in. and 6¾-in. hole drilling. In East Texas, 5¼-in. drill collars have successfully been used in 6¼ and 6⅛-in. holes, while in North Texas where 6¾-in. holes have been drilled, drill collar diameters have ranged up to 6 in. Indications are that the use of 4¾-in. drill collars in a 6¾-in. hole would result in a greater tendency for the hole to deviate than if 5¼-in. collars were used; drilling rate will be reduced if bit weight is decreased to control deviation.

Full gage replaceable blade stabilizers have been used in conjunction with 4¾-in. drill collars in drilling 6⅛-in. wells in Humble's Gulf Coast division area to aid in controlling angle; similar stabilizers, slightly under gage, have been used with 5¼-in. drill collars in 6¾-in. hole.

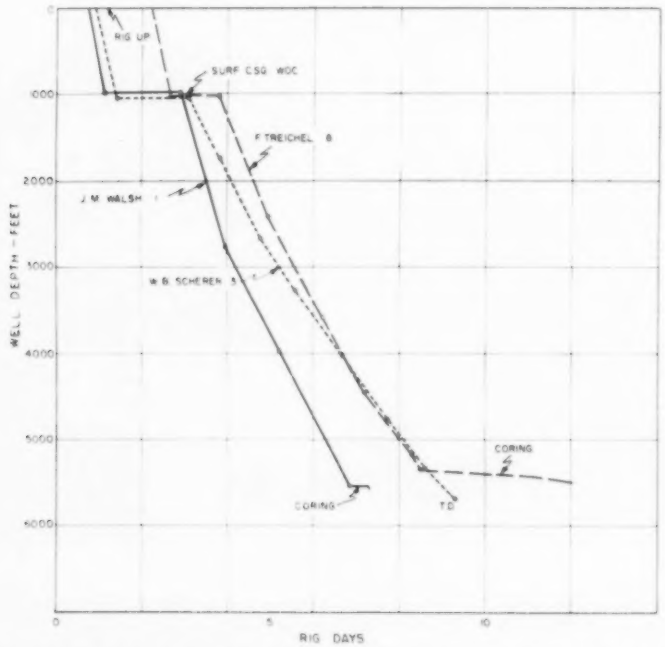

FIG. 3. **Tomball district, Gulf Coast** division of Humble, comparative drilling. This is the record to coring depth of J. M. Walsh No. 1, F. Treichel No. 8 and W. B. Scherer No. 3, 8⅝-in., 6⅛-in. and 4¾-in. holes, respectively.

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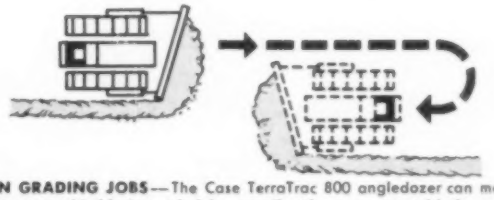
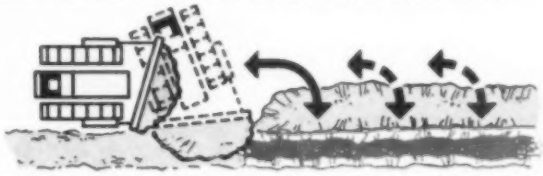


ON GRADING JOBS—The Case TerraTrac 800 angledozer can make one pass with blade angled in one direction . . . reverse blade angle while "counter-rotating" for next pass . . . thus keep pushing dirt in *same* horizontal direction, instead of backing up *empty*. Result: practically twice as much work done per day, at lower net cost.



ON BACKFILLING JOBS — You can peel-off part of a pile . . . sweep it into the trench . . . and "counter-rotate" back into pile *in seconds*, without touching a master clutch or stopping to shift gears. Result: more trench backfilled per day, with less operator fatigue.

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Mud and Hydraulics Requirements

Oil emulsion mud has been employed in most of the wells in which reduced diameter casing has been employed, and it is felt that in addition to increased penetration rates, danger of hole trouble and sticking pipe are minimized. For drilling in the 6¾ to 5⅝-in. range, sufficient mud pump capacity should be available to circulate 250 gpm at 1600 psi at least; minimum available pump horsepower should be 300. In order to avoid severely overloading gears in 14-in. stroke pumps while operating at high pressure, the pump should be run at maximum rated speed so as to allow use of smaller liners to attain the desired circulating rate. For drilling 4¾-in. holes 125 gpm pump capacity should be a minimum at 1400 psi with 150 hp available. Drilling efficiency could be greatly improved if small mud pumps were available to operate at 2000 psi or more for drilling holes of smaller diameter.

Fomation Evaluation

Drillstem testing, logging, and coring have given no unusual difficulty. Although conventional coring has been used to a great extent, recently a wire line assembly with soft formation head was used in conjunction with 2⅞-in. drill tubing in coring 398 ft in a 6⅛-in. Texas Gulf Coast well with an average recovery of 82 percent.

Casing and Tubing Sizes Employed

No difficulty has been experienced in running 4½-in. T&C casing in 6⅛-in. holes and 5 in. T&C casing in 6¾-in. holes as oil string. Both centralizers and scratchers are generally used on both sizes of casings to insure good cement jobs. Formation fracturing on completion has been successful in many wells.

In wells where no sand trouble is expected, standard 2⅜-in. EUE T&C tubing has been run inside 4¼-in. casing. In wells that may give sanding trouble, 2⅜-in. non-upset T&C tubing has been run. It is expected that a newly designed integral tubing joint combining API threads with an outside diameter smaller than that of an API coupling will soon be available; this will be stronger than the non-upset API T&C joint.

Another means of providing added annular clearance in 4½-in. cased wells prone to give sand trouble would be to run 1½-in. nominal, 1.9-in. OD, EUE tubing in place of 2⅜-in. tubing; the API coupling OD of this pipe is 2.5 in. Use of 1.9-in. tubing would also allow setting of 4-in. or 3½-in. casing, respectively, in 5⅝ or 4¾-in. wells where washovers are not anticipated. Producing capacity of 1.9-in. tubing will be adequate for many wells; logging, gun perforating, and artificial lift equipment are available for use in this size pipe including retrievable gas lift valve.

Air and Gas Drilling

The drilling of hole sizes to accommodate small diameter casing is quite suitable for air and gas drilling. One well in the North Texas area which had been previously drilled with gas was deepened from 6300 ft to 7579 ft using gas to drill a 4¾-in. hole. As hole diameters are reduced, the air or gas requirements to maintain a 3000 ft per min free air velocity in the annulus is also reduced appreciably. For example, drilling at 6000 ft, air or gas would be needed at a rate of 350 cfm in a 6¼-in. hole with 3½-in. drill pipe, compared with 1090 cfm for 8¾-in. hole with 5-in. drill pipe.

Humble's Results

Reducing hole size and casing diameter has proved to be a practical means of reducing well costs both for exploratory and development drilling.

Drilling time for wells of reduced diameter in most instances has been comparable to that for regular size wells.

Of prime importance is the provision of adequate mud pump horsepower at circulating pressures greater than usually associated with mud drilling. This is necessitated by higher friction losses in the hydraulic system using drill pipe of reduced diameter.

Use of portable-type rigs powered for handling small pipe reduces equipment and labor charges. Four and three man crews are being used on rigs used in drilling wells of reduced diameter.

Small hole techniques are quite adaptable for use with air or gas drilling as there is a reduction in air or gas volume requirements while at the same time, performance of small bits is improved. When using mud with small diameter drill pipe, the friction loss is relatively high, and this can be alleviated by using air or gas as the circulating fluid.

Equipment manufacturers are developing rigs, bits, pumps, drill tubing joints, coring and logging equipment, perforating guns, packers, wellheads, etc., for use in drilling and completing wells of reduced diameter.

Well bores having 4-in. or less diameter with corresponding reduction in casing OD are now within the realm of possibility. * * *

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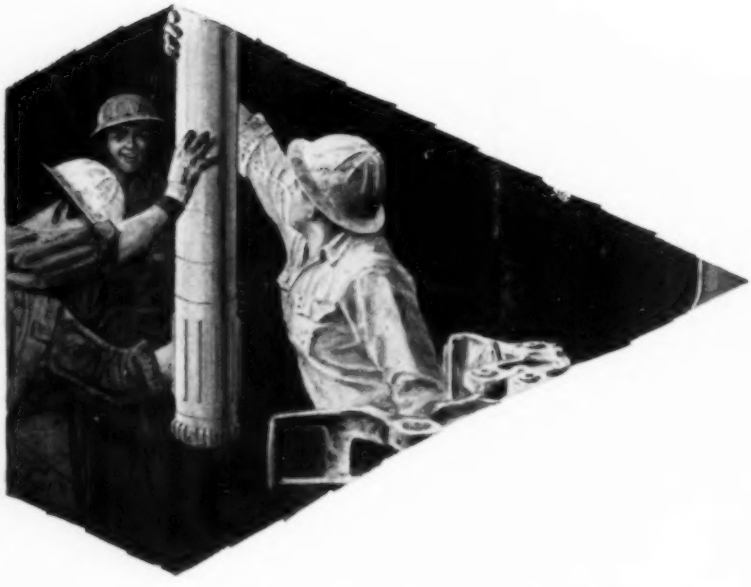

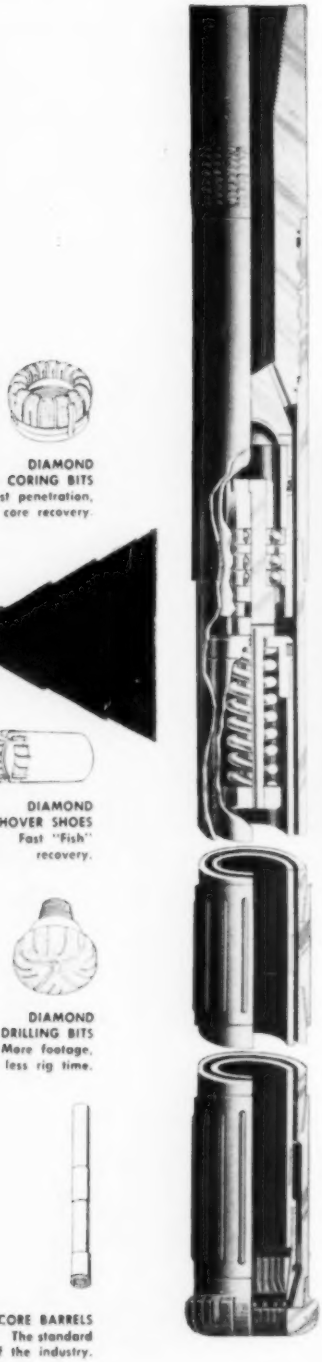

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Learning what goes on inside

'electrocardiograph' For a Mud Pump

Researchers make precision measurements to get the "inside" picture. Results aid analysis of performance, improvement of parts

AN extensive mud pump test laboratory has been set up to make precision measurements on instantaneous pressures, motion and sounds during pump operations. Objective is to study the motion of fluids and moving parts in mud pumps and how these effect pump performance.

In the same manner that physicians study the impulses of the heart, Mission Manufacturing Company, Houston, Texas, with the help of the Southwest Research Institute have assembled a comprehensive test unit to delve into the innermost characteristics of mud pumps and fluid behavior. Instruments have been built to measure instantaneous pressures, sounds, velocities, stresses, motion and many other factors within the pump. All tests are made under field operating conditions.

First results to come out of these extensive tests show interesting discoveries concerning knock in pumps. All pumps will knock under certain conditions and it has long been thought that this was caused by the mud valves banging shut or hitting the top of the cage. Measurements of valve travel during normal and then hammering operation (see Fig. 3) indicate this is not the case. Tests show that valves are not the cause of hammering but are severely buffed when this condition exists. Further study is being made into the actual causes of pump hammer.

Test Objectives

Several fields of interest resulted in the development of the test program. The first involved the nature and magnitude of forces causing mechanical failures. Other objectives were to determine the behavior of fluids within the pump and seek to improve volumetric and mechanical efficiencies. Also of interest was the study of hammer which limited the use of pumps in some application and the effect of line dampers and other auxiliary equipment on performance.

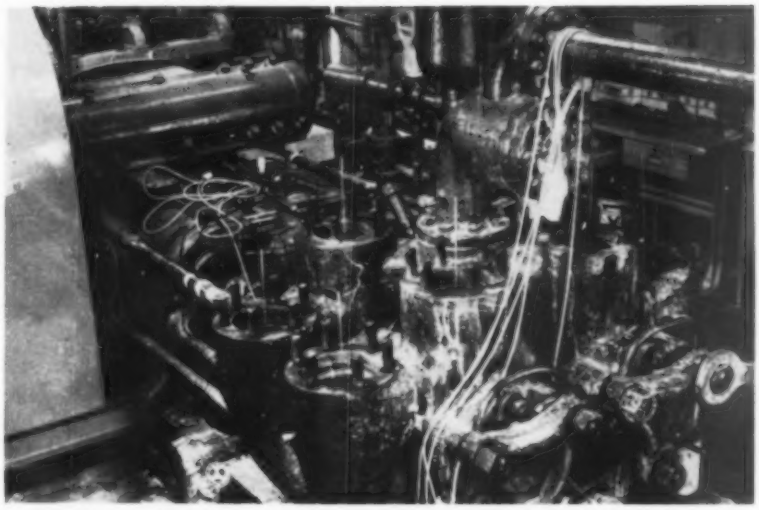
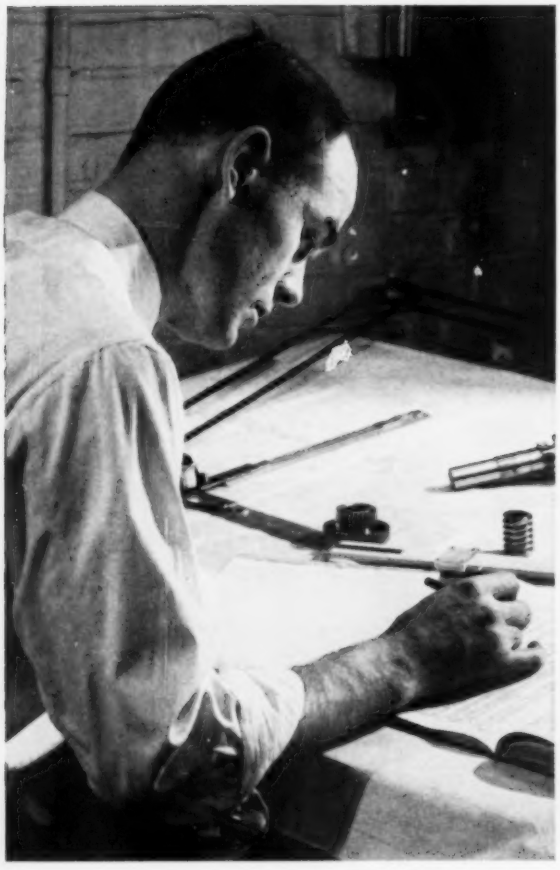
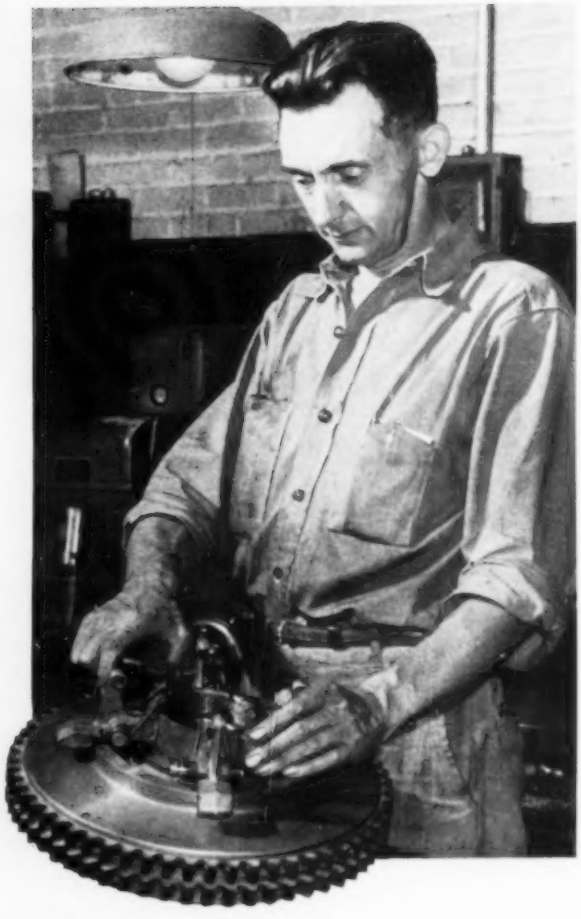


FIG. 1. **Instrumentation of pump** is compact but packs a volume of information into one small unit. Pump shown, in the process of being equipped, already has pressure pick-ups, valve travel indicators and pump rod stress gages in place.

FIG. 2. **Central instrumentation unit** has facilities for lining-up test on the oscilloscope and then recording several key measurements simultaneously.





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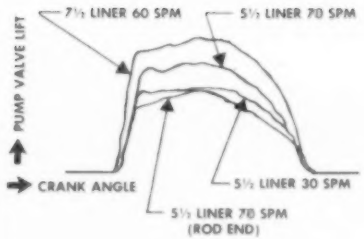
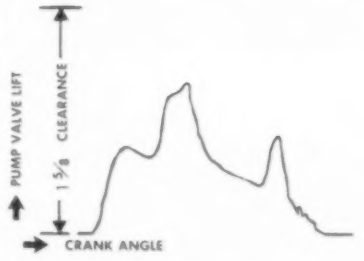


LIFT DURING NORMAL PUMP OPERATION



LIFT WHEN PUMP HAMMERING

FIG. 3. **Tests show that pump hammering** is not the result of valve flutter or banging. Reseating of valve during hammering run appears to have lower impact than normal run.

To accomplish these objectives, measurements of instantaneous pressures, velocities, stresses and motion of components were required. Strain gages are the main stay in the installation. Pressure is measured through use of these gages both directly bonded and end bonded to flat disc pressure indicators. Stress is obtained by bonded strain gages which record bending, compressional and tensile forces. Cantilever impingement devices measure mud velocities through the use of strain gages. Deflection is proportional to load. Data from this latter device, shown in Fig. 4, were found reliable except where shock waves or excessive pressure surging was encountered.

Measurement of valve stem and piston travel was facilitated by a linear transformer. Motion of the core of this device renders an electrical signal. Sound is picked up by a conventional microphone mounted at the point of investigation.

High speed fluctuations of measured variables require rapid recording equipment. In test operations, an oscilloscope is used to line up the measurement to assure that data are suitable for analysis. Cycles are then recorded with a recording oscillograph and these tracings are utilized in the study of pump operations.

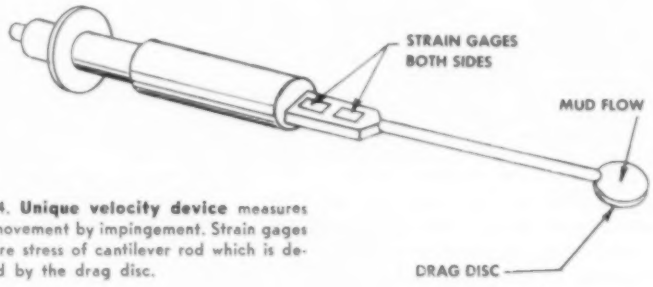


FIG. 4. **Unique velocity device** measures mud movement by impingement. Strain gages measure stress of cantilever rod which is deflected by the drag disc.

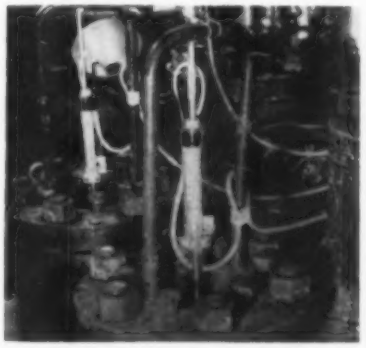


FIG. 5. **Valve movement** was considered an essential phase of the pump tests. Devices shown are linear transformers which generate an electrical signal when valve stem moves.

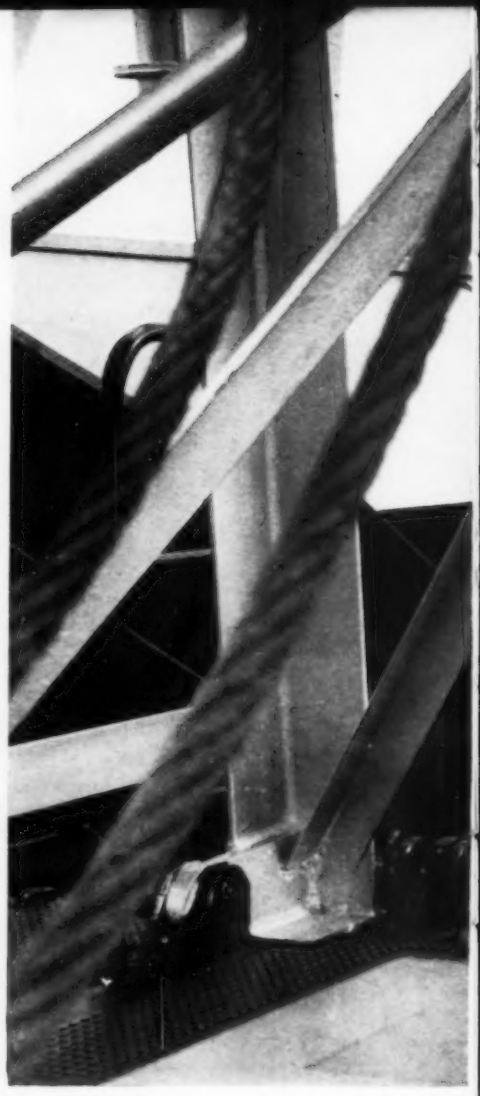
Voluminous Data Wait on Analysis

Voluminous data have been collected from runs of the test installation. However, time is required for analysis and verification of data. As in the case of the so called "valve hammer," it is anticipated that many theories or beliefs will be disproved or qualified by future tests. With this new comprehensive approach to pump testing it is anticipated that many things will be learned to improve mud pump performance in the field.

Acknowledgment

Information, data, photographs and charts from which this discussion was prepared were generously provided by Mission Manufacturing Company, Houston, Texas. ★ ★ ★

Why General Electric Drive Proves Best For Oil Well Drilling Rig Electrification



1 Control simplicity inherent in motor and generator design. General Electric's differential generators eliminate the need for complicated external current and voltage regulating controls, feed-back systems, and torque limiting devices used in some makes of electric drive. Moreover, General Electric's familiar air throttle system eliminates the individual exciters for each generator. The G-E shunt motor will not run away in case of load loss and therefore requires no speed-limiting control devices. This motor has excellent braking characteristics without any added controls. All control provided for the General Electric drive system assures complete regulation of speed and torque simply and efficiently.

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3 Designed and built by the original manufacturers of electric drive. General Electric is primarily an electrical equipment manufacturer with years of experience in the manufacture of electrical apparatus. The simplicity and flexibility which mark General Electric drive are the result of leadership in the electrical field. The electric drive that will mean so much to your rig operation and to your cost per foot of hole has been pioneered and developed by G.E.

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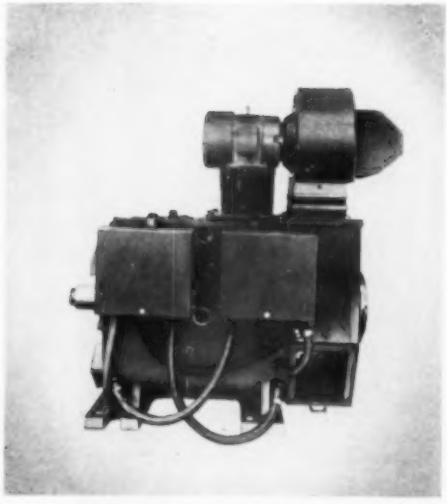
GT558R1 direct current main generator with inspection covers removed.

Operator at drilling controls of General Electric equipped rig built for Shell Oil Company by Ideco, one of the Dresser Industries. Standard air throttles are used for speed controls. These can be incorporated in the draw works console with other air controls, simplifying operation.

GENERAL ELECTRIC DRIVE COMPONENTS:



GE752J direct current main generator with top-mounted blower assembly.

GE752H2 direct current, 1000 hp motor with top-mounted blower assembly.

General Electric control console for use at driller's position.

Productivity index simplifies calculations for up-the-hole

Placement of Subsurface Pumps

Graphic plotting method proved in high fluid producing wells in Western Kansas

Owen Snow,
Colorado Oil and Gas Corporation, Wichita, Kansas

A few pencilled calculations based on fluid level and fluid production data can result in increased oil production and increased equipment life.

Using a method worked out in high fluid producing wells in western Kansas to properly relocate subsurface pumps up the hole, several marked effects have been found. Not only has production increased noticeably but several physical characteristics have changed. These advantages include:

1. Higher pump efficiency (since rod stretch is lessened).
2. Rod load is smaller.
3. Fluid load is increased (with larger pump plunger and greater pump efficiency).
4. Peak torque is decreased.
5. Beam load is less.

These changes afford longer pumping unit life, longer rod life, and more fluid production. Although the relocation of the pumps would be worthwhile even if only the life of the equipment is lengthened, it is made more attractive in that quick servicing payout is reported.

The Kansas wells benefitted by this method of subsurface pump relocation are completed in the Arbuckle formation. Like the Oakville sand wells of South Texas, "lots of water must be produced to get any oil." Relocating the pump up the hole will ultimately give the operator more fluid production, which in turn will yield more oil.

"Hit or Miss" Expensive

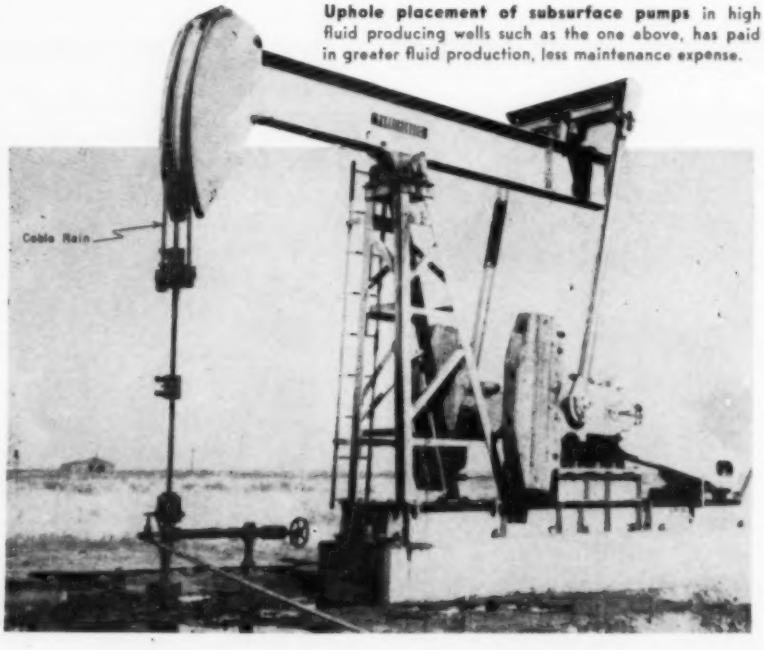
When raising the pump, trial and error methods in the field are too expensive. This often finds the pumping unit pounding fluid, thus requiring a pulling unit back on the location to lower the pump. By calculating pump position on paper, this unnecessary field operating expense is eliminated.

Field Data Necessary

Before making these calculations, however, certain field data must be gathered. Fluid level must be determined and fluid production known. Using a sonic tester, load indicator or dynamometer, fluid levels are obtained. One static fluid level and two working fluid levels are required. Fluid production at each fluid level should be obtained with a production test (or barrel test). Three fluid levels and fluid production tests should be taken, should one set of tests be in error.

Graph Plotting

Basic field data may now be transferred in graphic form on semi-log paper. Fluid levels are plotted on the coordinate scale and fluid production on the log scale. Three or four plots



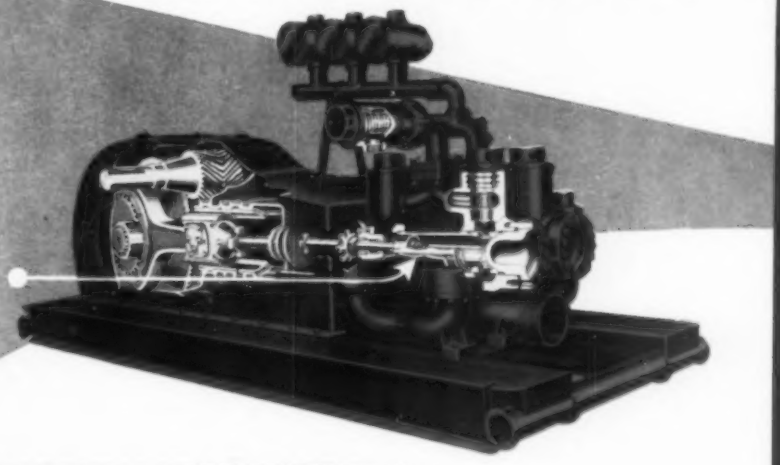
Uphole placement of subsurface pumps in high fluid producing wells such as the one above, has paid in greater fluid production, less maintenance expense.

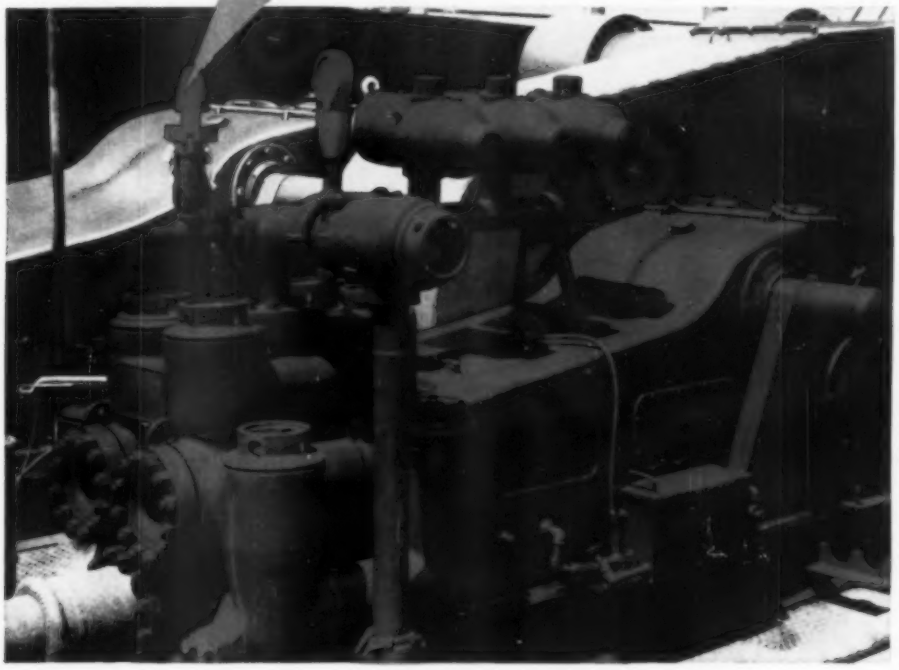
*Rule of thumb.
Kansas personnel, using the method presented herein, found by experience that rods woul dnot fall properly, in most cases, if the subsurface pump was placed at a depth less than 2500 ft from the surface.

THE PATENTED *"Exposed"* LINER DESIGN OF

CONTINENTAL-EMSCO SLUSH PUMPS

saves you time, money and inconvenience





One of the many exclusive and superior advantages of the Continental-Emsco Slush Pump is the patented "exposed" liner design. This eliminates all fluid washouts caused by lining packing failure since the slightest leak may be detected immediately.

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They work day in, day out — season after season. Simplicity is a keynote of Allis-Chalmers design. For instance, one model has *30 to 50 percent fewer wearing parts than competitive engines!* Naturally, fewer parts mean less wear, less that can go wrong.

You enjoy 3-deep parts and service backing with practically "factory-town" service wherever you are! Allis-Chalmers' proven 3-deep dealer-branch-factory system means your dealer can obtain parts or factory-trained service help quickly from one of *18* strategically located factory branches.

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BO-5

NEW "SELF-SEALING" RING GASKET

Cameron has developed a new gasket for standard API flanges.

Internal pressure is used to assist in effecting a safe, sure seal with only a fraction of the bolt tightness needed by conventional API gaskets. This reduces nipple up time to a minimum and gives greatly increased protection against leakage resulting from drilling vibration, rough handling or test pressure loads. You can forget about frequent, time-consuming bolt retightening.

AN OPEN LETTER TO THE OIL TOOL INDUSTRY

Cameron is making the "Self-Sealing" Ring Gasket available to the industry.

Along with every other member of the industry, Cameron has been constantly concerned with the problem of maintaining tight API flange connections.

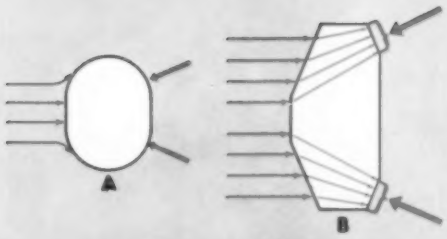
Difficulties and expense have long been experienced because stud bolts had to perform the double duty of holding pressure while keeping the gasket compressed.

The obvious answer to this problem is to use internal pressures rather than bolt loading to effect a seal.

Cameron, through extensive research and development, has produced the "Self-Sealing" Ring Gasket design. Increasing ring height and proportionately increasing loading by pressure on the outer face of the ring has created a self-sealing condition.

To the advantage of all concerned, Cameron is releasing this design to the industry without requiring license fees or manufacturers' royalties.

New "Self-Sealing" Ring first makes contact on this outer surface creating an initial seal. Even with wear on both ring and flange, low torque will effect a perfect seal. Increased pressure increases tightness of seal.



A. The small curved contact areas of the old style ring gasket effect a seal only with high bolt loading. Because they yield under load, continuous retightening is necessary. Internal pressure does not aid in maintaining a seal.

B. The "Self-Sealing" Ring Gasket utilizes the force of internal pressures to increase sealing effect over the two broad surfaces on its outside diameter. Contact areas with the flange groove are increased tremendously. The result is better sealing effect and much greater load carrying ability.

This view shows increased height of the new "Self-Sealing" Ring. Larger contact areas increase mechanical stability with low bolt loading.

"Self-Sealing" Ring Gaskets are manufactured in sizes to replace old style API rings from 6" 3,000 lb. through 14" 5,000 lb. All other standard sizes available on special order. These gaskets use standard stud bolts and nuts. "Self-Sealing" Ring Gaskets may be purchased directly from Cameron or from your regular source. In the event your source cannot make delivery on this new type "Self-Sealing" Gasket, please advise that complete specifications including all engineering data for their royalty-free manufacture may be obtained from Cameron at no cost whatsoever.

This self-sealing principle is also used in a tentative design for 15,000 lb. working pressure flanges.

Cameron

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In England: Cameron Iron Works Ltd., Time & Life Bldg., New Bond Street, London W. 1 England

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For use with both 36-L and 48-L spudders, Bucyrus-Erie's heavy-duty tripod derrick has sufficient height and stability to handle casing loads up to 300,000 pounds when rigged for 10-part hoist. Completely raised, the derrick is 70' 4" high.

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36-L Top-to-bottom drilling to 3,500 feet. Servicing to 4,000 feet. Swings up to 5,000 pounds of tools.

48-L Top-to-bottom drilling to 6,000 feet. Servicing to 7,000 feet. Swings up to 6,700 pounds of tools.

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1. Derrick sections are assembled on the ground. Legs are hinged to the base and the gin pole is set in place preparatory to raising derrick.

2. Using the bull reel drum for hoisting, the derrick begins to rise. Hinged front lower section is pulled into place by the derrick hoist.

3. When the derrick is completely raised, the gin pole is removed and the front lower section is attached.

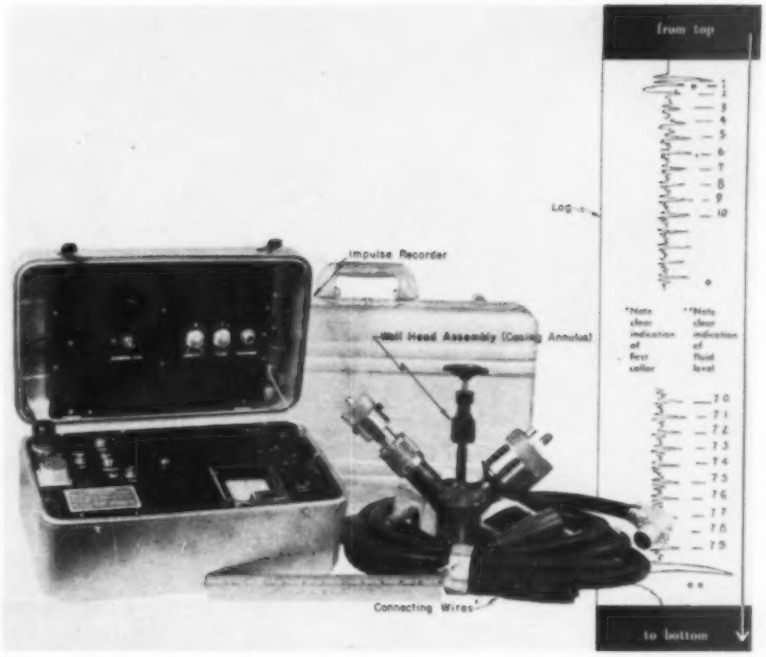
should be made. Then by trial and error, subtract (or add) an equal amount of production from each point until these three or four points fall in a straight line. It should be noted that the static point does not change. (See Fig. 1 and 2.)

Having plotted this curve, top of the producing zone perforations (or open hole) can be plotted. From that point, going to the log scale, fluid production can be read. To the production, add the amount of production subtracted to shift the curve. This total represents the fluid potential of the producing interval of the well.

Operating Conditions

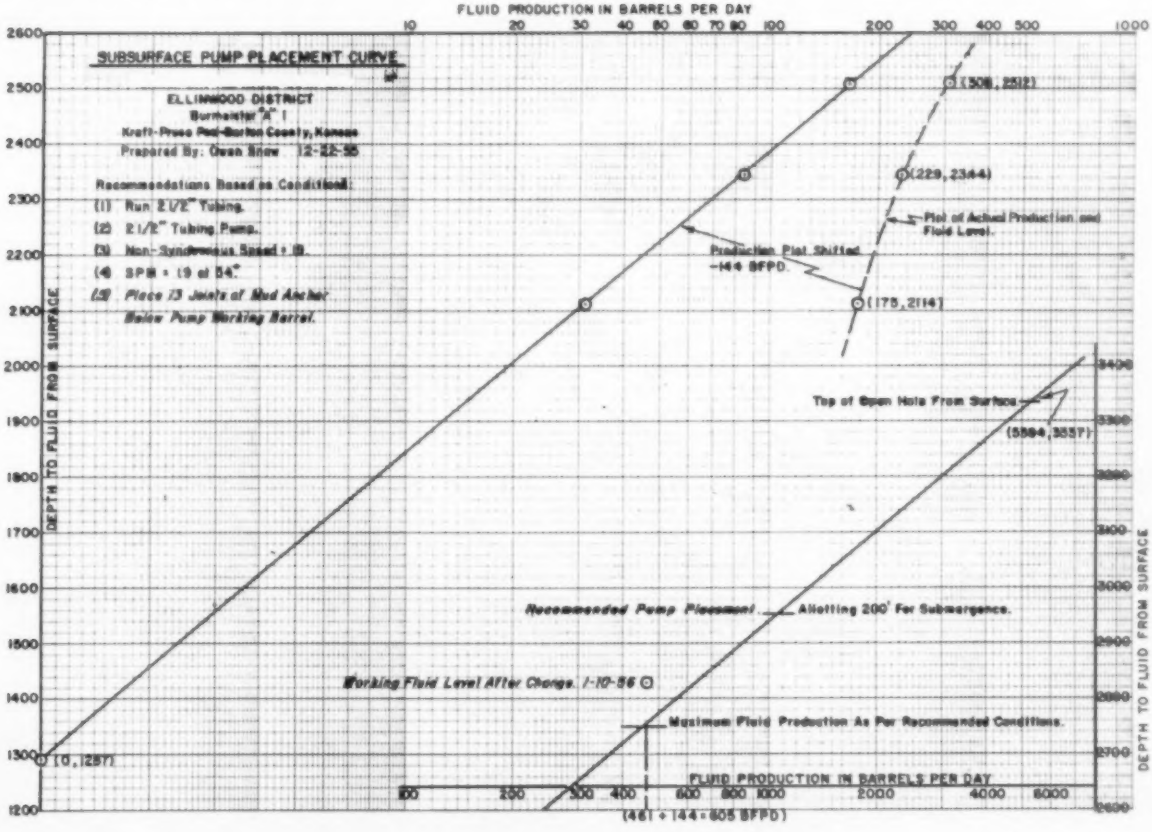
Several operating variables must be considered and equipment picked to do the job. These should be considered:

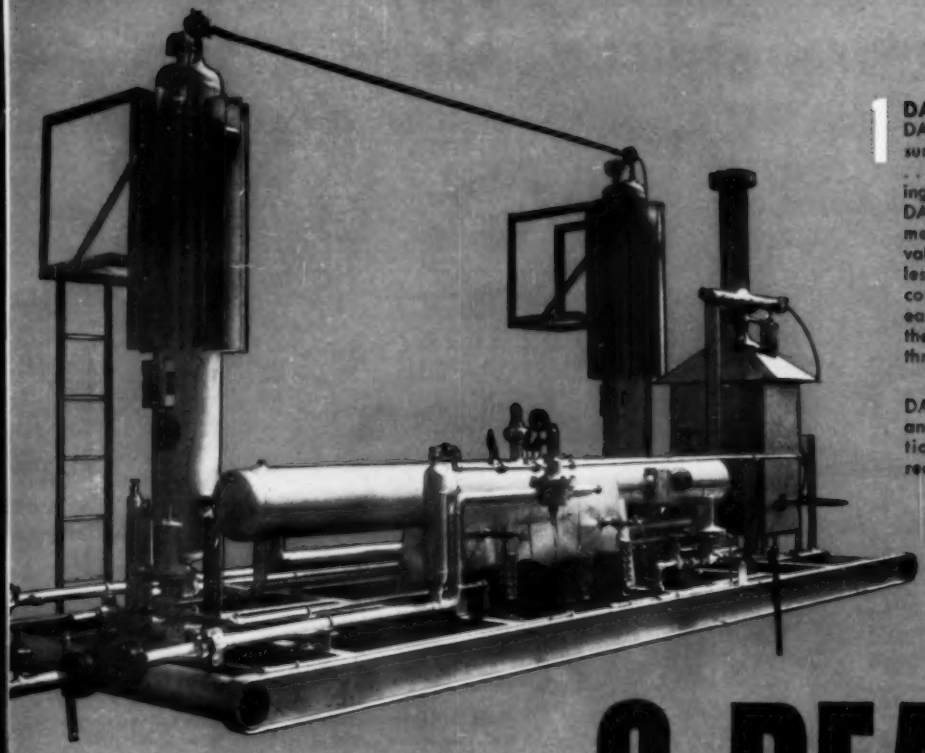
1. Size of tubing.
2. Type of pump (insert, tubing, or double displacement).
3. Size of pump plunger.
4. Non-synchronous speeds.
5. Pumping unit speed and length of polished rod stroke.



Fluid level measurements can be made by the use of such instruments as the sonic device shown above. Note fluid level "kick" on chart strip at right.

Subsurface pump placement curves used to relocate the pump in Burmeister "A-" 1 well in western Kansas.


FLUID PRODUCTION IN BARRELS PER DAY
SUBSURFACE PUMP PLACEMENT CURVE
ELLINWOOD DISTRICT
Burmeister "A" 1
Kraft-Prusa Pool-Barton County, Kansas
Prepared By: Owen Snow 12-22-55
Recommendations Based on Conditions:
(1) Run 2 1/2" Tubing.
(2) 2 1/2" Tubing Pump.
(3) Non-Synchronous Speed + 13.
(4) SPM + 19 at 54".
(5) Place 13 Joints of Mud Anchor Below Pump Working Barrel.
(508, 2512)
(229, 2344)
Plot of Actual Production and Fluid Level.
Production Plot Shifted -144 BFPD
(175, 2114)
Top of Open Hole From Surface
(5584, 3557)
Recommended Pump Placement — Allotting 200' For Submergence.
Working Fluid Level After Change, 1-10-56
Maximum Fluid Production As Per Recommended Conditions.
(0, 1287)
(461 + 144 = 605 BFPD)
DEPTH TO FLUID FROM SURFACE



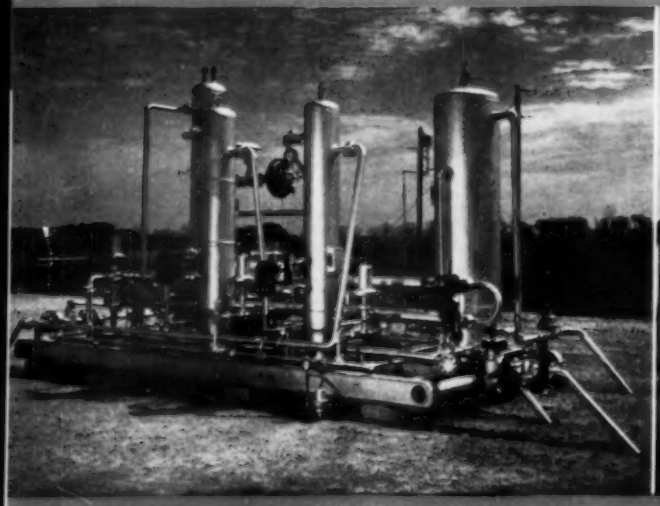
1 **DAU . . . a Parkersburg exclusive!** With DAU, wellhead dehydration of high pressure gas wells is possible for the first time . . . and with real economy, too. Your savings start with the low cost of unit. The DAU requires no costly auxiliary equipment such as separators, piping and valves. Because the DAU uses 80 per cent less fuel gas, your savings on operating costs can amount to hundreds of dollars each month. And checking corrosion at the wellhead saves on equipment wear throughout the flow system.

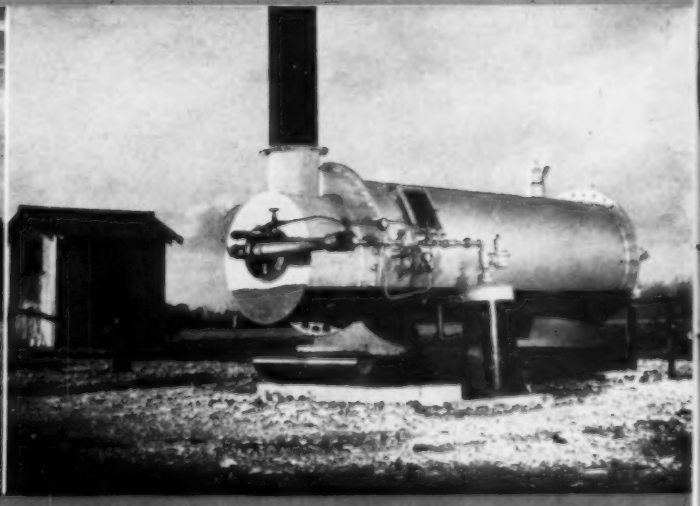
Available in two basic types: (1) The DAU Weldrier for wellhead dehydration; and (2) The DAU Welsorber for combination dehydration and hydrocarbon recovery.

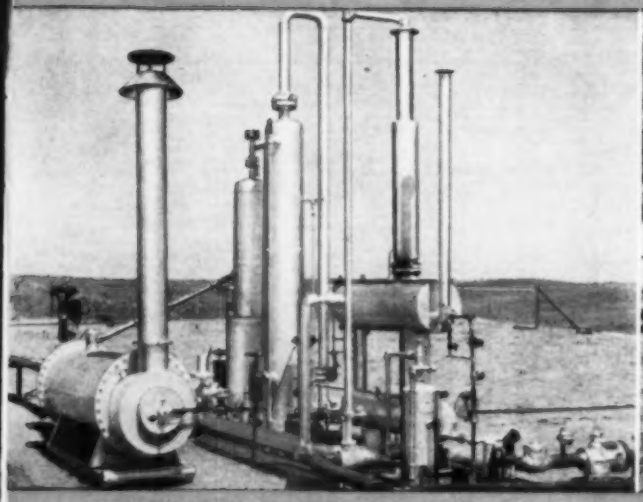
6 REASONS

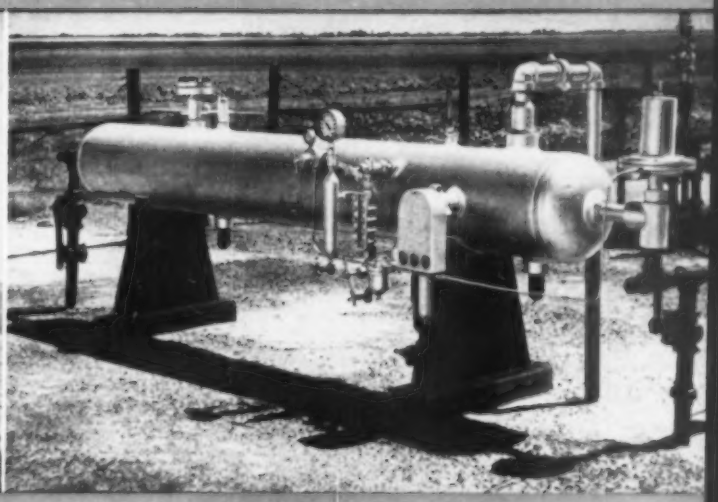
2 **HYRECO . . . another significant Parkersburg development.** Parkersburg pioneered the design and development of this equipment to obtain high recovery rate by cold separation. Top performance attained through such Parkersburg features as use of horizontal and vertical separators to isolate warm liquid zone from cold gas zone for maximum recovery and minimizing danger of freezing; vertical knockout for complete removal of liquids before well stream enters cold zone of high pressure separator; and liquid level controller, used to regulate elimination of hydrocarbons from warm zone of separator, that gives hair trigger sensitivity, freedom from freezing, and freedom from plugged bleed holes. Available in capacities from 2.5 to 15 MMCF/D; pressures from 2000 to 6000 psi with either single tube or twin tube vertical knockout for liquid removal.

3 **HEATERS . . . superior quality and performance.** Parkersburg heaters are available in both direct fired and indirect heater types with capacities from 90,000 to 4,000,000 BTU's. Exclusive heating tube design eliminates hot spots and scale deposits, gives more efficient, economical and dependable service. Indirect heaters now feature new, modern jet-type burner and pilot that requires no air-fuel adjustment, gives maximum flame stability because only primary air is used with fuel gas, and, because of design of wall-tight burner box and flame stability, is practically immune to ill effects from crosswinds. Finest auxiliary control equipment available insures peak effectiveness. All valves and regulators used on Parkersburg heaters are designed for oil field application.









4 **GLYCOL TYPE GAS DEHYDRATOR** ...a self-contained, completely automatic unit that will eliminate most hydrate problems. Proven performance in extremely cold temperatures. Economical operating cost, using natural gas as source of power. Available in standard sizes to handle up to 10,000 MSCFD and up to 1500 psi operating pressure.

5 **OIL AND GAS SEPARATORS** . . . available in vertical and horizontal types. Parkersburg single-tube separator gives more gas flow area, more interface area and more retention time for greater separation. Whether your need is for a single-tube, two stage, three phase, vertical or metering separator, there is a Parkersburg separator to fit your requirements.

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We are known by the equipment we keep. Parkersburg production processing equipment is the recognized leader in the field . . . a leadership gained through pioneering new designs and applications of equipment to meet any field problem. Operators everywhere buy Parkersburg with confidence because they know the superior performance that is built into each piece of equipment. If it is a Parkersburg, it is designed right and built right for leadership and engineered to meet specific field conditions.

The Parkersburg representative in your area will appreciate the opportunity to discuss specific equipment needs with you.

6 **EMULSION TREATERS**. . . designed to cover a wide range of applications. Safe and easy to operate. Equipped with unitized fuel gas control line and wind-proof burner control hood. Large free-water knockout capacity, adequate oil settling height. You get more specific separation of emulsion into clean oil and water, greater maintenance of high gravity oil.

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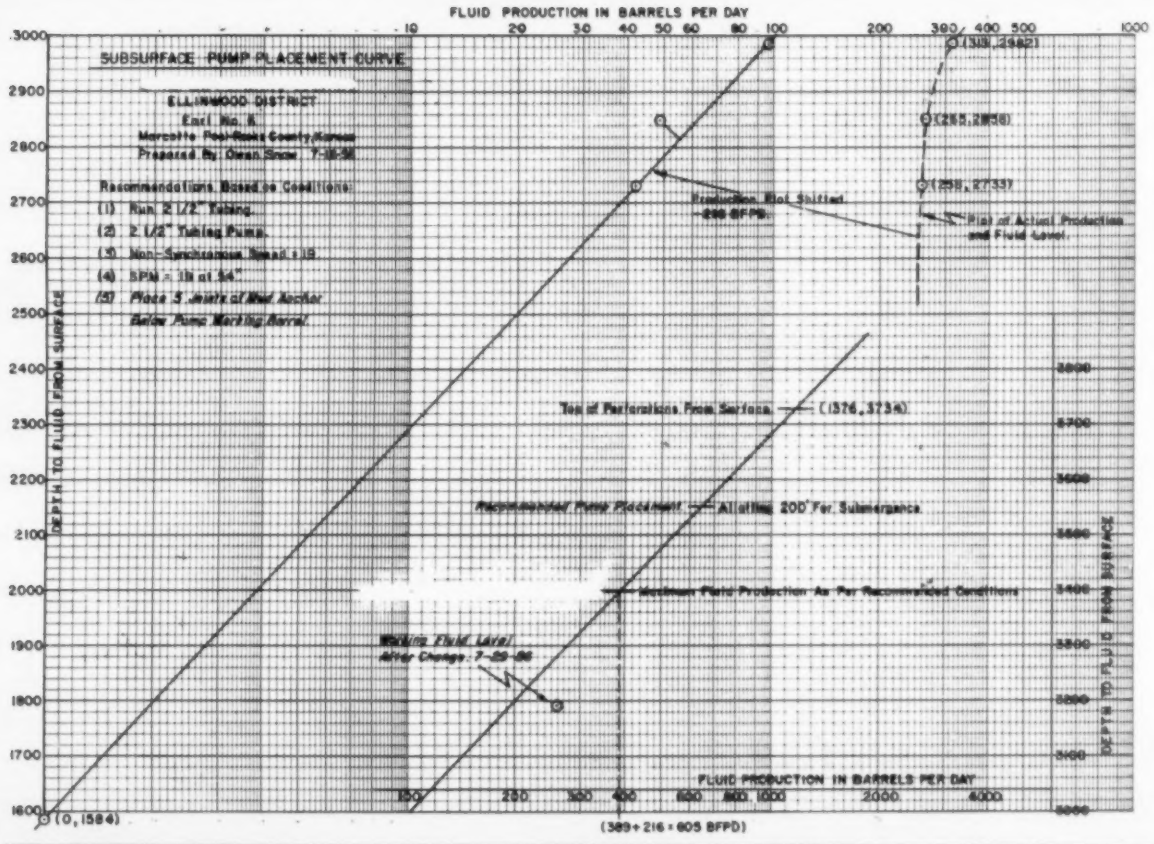
FLUID PRODUCTION IN BARRELS PER DAY
SUBSURFACE PUMP PLACEMENT CURVE
ELLINWOOD DISTRICT
Earl No. 8
Marcotte Pool-Stone County, Kansas
Prepared By: Dean Snow 7-25-56
Recommendations Based on Conditions:
(1) Run 2 1/2" Tubing.
(2) 2 1/2" Tubing Pump.
(3) Non-Synchronous Speed - 1B
(4) SPM - 18 at 54"
(5) Place 3 Joints of Mud Anchor Below Pump Working Barrel.
DEPTH TO FLUID FROM SURFACE
Production Rate Shifted -200 BFPD
Plot of Actual Production and Fluid Level
Top of Perforations From Surface (1376, 3736)
Recommended Pump Placement Allowing 200' For Submergence
Maximum Plate Production As Per Recommended Conditions
Working Fluid Level After Change 7-25-56
(0, 1584)
(389+216=605 BFPD)
FLUID PRODUCTION IN BARRELS PER DAY
DEPTH TO FLUID FROM SURFACE

ON TOP FOR ONE REASON
Lem
because it has proved tops
RUN IN POSITION
SET POSITION
LARKIN LEADERSHIP HAS BEEN EARNED

Application of curves on semi-log paper to determine proper pump placement for Earl No. 6 well in the Marcotte pool of Rooks County, Kansas.

Calculate:

1. Beam load.
2. Rod stress.
3. Peak torque.

After these operating conditions have been considered and picked, production must be calculated, based on 100 percent pump efficiency.

Next, plot production on the graph, after subtracting the amount of production required to shift the curve. From the last point plotted, a depth can be read by going to the coordinate scale. To the depth add 200 ft for submergence (or calculate the required submergence). **The answer obtained is the subsurface pump placement depth.**

Special Considerations

A tubing support can be placed on the tubing string at the pump placement depth. If a mud anchor is to be used, length of this assembly may be calculated by subtracting the pump placement depth from the well's total depth and dividing by the average tubing-joint length; the answer will be the number of joints of mud anchor required.

To allow corrosion inhibitor to protect the mud anchor, a seating nipple or working barrel should be placed above the top joint of the mud anchor, and a perforated nipple should be placed on the bottom joint of the mud anchor.

TABLE 1. Production Data (Before Pump Change).

Lease and Well No.	Depth to fluid from surface (feet)	Barrel test: Barrels fluid per day	Barrel test: Barrels oil per day	Barrel test: Water percent
Burmeister-A No. 1	2512	308	9	97
Earl No. 6	2982	313	25	92

Field Applications

This method for determining the placement depth of subsurface pumps is actually taking advantage of the productivity index of the well. It has been used on several high fluid producing wells in Kansas.

TABLE 3. Production Alteration (After Pump Change).

Lease and Well No.	Depth to fluid from surface (feet)	Barrel test: Barrels fluid per day	Barrel test: Barrels oil per day	Barrel test: Water percent
Burmeister-A No. 1	+322	+302	+9	0
Earl No. 6	+211	+159	+8	+1

Results of two wells are tabulated in Tables 1, 2, and 3.

Payout

Only expense of relocating pumps is

TABLE 2. Production Data (After Pump Change).

Lease and Well No.	Depth to fluid from surface (feet)	Barrel test: Barrels fluid per day	Barrel test: Barrels oil per day	Barrel test: Water percent	P.I. Maximum production (BFPD)
Burmeister-A No. 1	2834	610	18	97	5394
Earl No. 6	3193	472	33	93	1376

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The Author

Owen Snow is district petroleum engineer for Colorado Oil and Gas Corporation in Wichita, Kansas. He began his oil career as a roustabout for the old Sunday Oil Corporation, during summer, while attending the University of Oklahoma. He was graduated from OU in 1953 and joined Magnolia Petroleum Company in Alice, Texas, as a petroleum engineer. Later he accepted the position of district engineer with Champlin Refining Company (subsidiary of The Chicago Corporation) in Ellinwood, Kansas. In that position he supervised installation and operation of a successful Pennsylvania Conglomerate waterflood in Rooks County, Kansas. He resigned that post to join the staff of Colorado Oil and Gas Corporation as assistant to the district petroleum engineer, recently rising to his present position.

the pulling unit cost. Payout for this expense is achieved quickly, as noted in Table 4. The payout period is based only on the increase in oil production resulting from replacing the pump.

TABLE 4. Pump Relocation Payout.

Lease and Well No.	Payout time
Burmeister-A No. 1	11 days
Earl No. 6	13 days

Cable Rein Buoyancy

Additional weight may become necessary to overcome fluid buoyancy and dynamic-reciprocating loads if a cable rein is used to carry the rods. This factor should be kept in mind when applying this method to field applications. In an extremely high fluid level well, where small casing sizes are involved, a cable rein forms a flexible connection and the rod weight must therefore exceed the buoyancy and dynamic-reciprocating loads so that the rods and plunger will drop their full stroke. More weight, in the form of additional rods, may be necessary.

In one Kansas well, a pumping unit's non-synchronous speed was 19½ strokes per min; however, at speeds greater than 17½ strokes per min, the polished rod would be lifted from its seat on the reins. This situation was alleviated by adding a few more ¾-in. rods in the well (making the total dry rod weight equal to 4100 lb), thus attaining 19 strokes per min and causing the polished rod to drop properly.

Pump Relocation Pays

If necessary well data can be obtained on high fluid producing wells and is put to use by the production engineer, recommending the relocation of one subsurface pump each month, then for self-satisfaction, that person can consider he is paying his own salary for the company. ★ ★ ★

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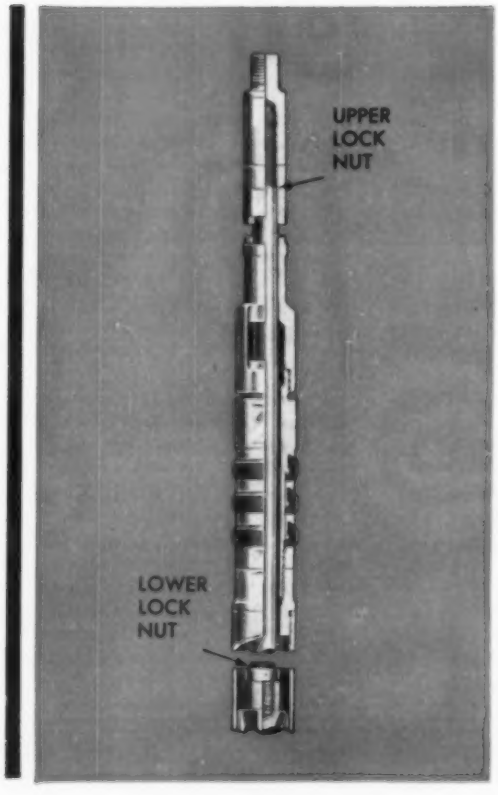
eliminate expensive fishing jobs...



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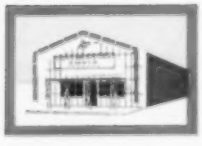
LOWER LOCK NUT ALSO PREVENTS VALVE ROD BREAKAGE AND ALLOWS A MEANS OF REMOVING PUMP WITH THE ROD STRING.

No matter what your subsurface pumping problem, you will find a D+B precision-built pump will meet your needs. Superior performance and proven design spell longer pump life and low maintenance. Prompt pump shop service is available when and where you need it from Continental-Emsco D+B Pump Shops and field men in all major producing areas.



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P-702

Gulf Oil Corporation Develops New Exploration Tool Called . . .

Gulf Seismic Profile Printer

Sound waves, translated into photographs of cross-sections of the earth, point way to better interpretations

A new seismic recording system has been developed in which seismic sections, printed photographically in variable-density form, simulate geologic cross-sections. It has been acknowledged as a triumph in translating sound into graphic form.

It takes the sound waves, sent underground by seismic prospectors to probe the position of rock strata, and photographically transforms them into cross-section pictures of the underground area.

The result is the most detailed and accurate picture of the domes, faults, and other structural features present underground ever available from surface observation. Likeness of the photographs to geologic drawings of known cross-sections is striking.

By giving prospectors the most complete information so far obtainable for outlining likely locations for oil accumulations, the method promises to materially better the odds on finding oil in wildcat explorations and in locating profitable wells in existing fields.

It may also reopen some regions considered "exhausted," and convert them into new petroleum resources. This was borne out when the method recently accounted for two oil discoveries in a West Texas area previously prospected over without result.

Operationally, the method adds to the speed with which prospecting data can be utilized and frees skilled manpower from the time-consuming work required to interpret the former type of seismic record.

The development is described in a technical paper by E. M. Palmer, geophysical engineer of Gulf Research & Development Company, as perfecting a 20-year research effort to "see underground" by aid of the seismograph.

How method was developed. This was achieved by improving and combining two seismic techniques called, respectively, "variable density recording" and "profile printing." The former is a means for photographically recording seismic sound; the latter is a method for interpreting the resulting photographs.

In seismic prospecting, small dynamite charges send sound waves into the rock layers. Originally, the returning echoes vibrated a pen which traced wavy lines on a paper tape. From such records selected portions only (due to the time-consuming calculations involved) were interpreted into cross-section charts partially showing the depth, thickness, type and position of rock layers — but with large portions left blank.

In contrast, the "variable density" technique, which Gulf improved under license from its inventor, makes every recorded whisper usable in a complete, finished cross-section photograph, in the following manner:

The sound waves, bouncing back from the underground rock, activate tiny electric bulbs which glow with varying intensity according to the echo's duration and strength. This changing pattern of brightness is recorded on moving 70 mm photographic film.

Twenty-four "tracks" of light are made lengthwise along each film strip, one for each of the 24 stations usually used for picking up the explosion echoes.

The "variable density" film strips were at first pasted side by side to give a continuous picture of an area prospected over. Rock strata were outlined so clearly by varying impressions of light on the films that the paste-ups proved visually understandable without translation into cross-section charts.

Such paste-ups were employed by the company with notable results in Canadian explorations.

The profile printer. Gulf researchers completed the system by their development of the "profile printer." This machine overcomes certain variations which occur between the strips, due to differences in time, station locations, and other inherent factors, when they are joined by hand.

Superseding the paste-up method, the "printer" adjusts each "variable density" strip so as to perfectly match those from adjoining areas in time and space relationships. It then prints each strip in turn on a continuous photographic sheet, creating a wholly integrated cross-section photograph.

Unlike the original hand-made seismic charts, the photographic cross-section reproduces the entire pattern of the seismic echoes from a prospected area including all minor and major fluctuations. This reveals many significant facts which, until this development, have been inaccessible to the prospector.

The difference between old and new systems can be compared to looking at a mountain mass at night when only major shapes stand out and at noon when every detail is clearly delineated.

Much complicated equipment, from the "variable density" recorders, photo copiers, and instruments to synchronize the various films for timing and other factors are required in the complete system. Development of the mechanical devices took years of work and large financial expenditures.

Compact, detailed picture. The result, to paraphrase Palmer's paper, is a system for presenting seismograph surveys which compresses the great mass of information obtained into a compact picture which nevertheless retains all details. On the other hand, it expands the usefulness of the data by displaying it in readily visual form.

Gulf is not the only company that has been working along these lines although it believes its solution is considerably in advance of others. In fact several major oil companies and seismograph contractors are interested in the device. ★ ★ ★

Did You Ever See a Double Headed Pump?

This unusual installation is operated by Low-Cost Utility Electric Power

Pumping from different depths but through the same casing, these pumps can be operated simultaneously or singly. Each is operated by AUTOMATICALLY CONTROLLED push-button power – ELECTRIC POWER.

While such installations are not common, it is standard procedure in most fields today to utilize Utility Electric Power because of the overall LOWER COST, greater efficiency, and numerous special benefits.

For helpful counsel on how you can benefit, call the Power Engineer of your Utility Electric Service Company.

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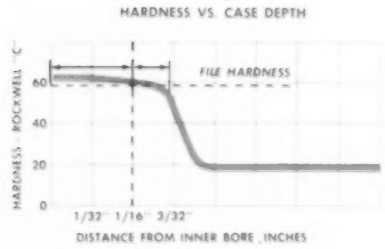
This means that Mission Liners wear slowly *throughout their entire life*. They wear far longer than some liners which start out wearing slowly, but "give up" fast after the thin case is worn off and softer metal is reached.

The graph *at the right* shows that hardness and depth of hardness are perfectly uniform throughout the length of the liner. There are no soft spots to wear unevenly.

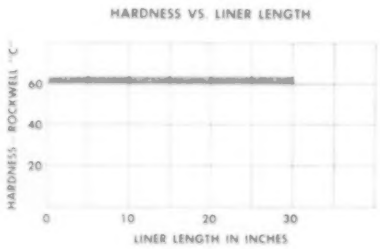
It's not easy to get uniformity like this. It takes the finest and most modern induction hardening equipment, plus a lot of care and metallurgical skill—elements not available to some manufacturers.

Although liners may look a lot alike, there are big differences that don't meet the eye. Some are flame hardened, some are carburized and some utilize other special techniques. Mission has tested many liners made by various methods but found nothing to produce results like those obtained from induction-hardened Mission Super-Service Liners.

Play it safe! For the best in slush pump performance specify MISSION when you order liners from your supply stores. You will save money and trouble when you do.



This graph shows that Mission Liners have a true "File Hard" bore throughout the useful wearing depth of 1/16". This means long liner life.



This graph illustrates that hardness is absolutely uniform throughout the wearing area of the liner. This means uniform slow wear.

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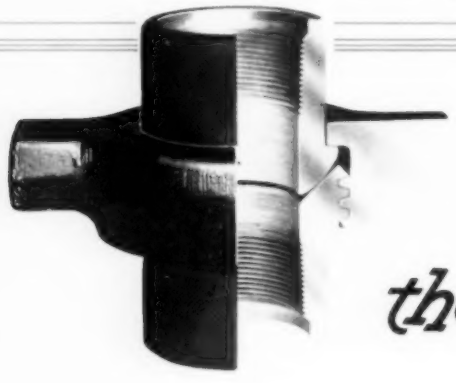

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For Possible Adoption to API Standards

Improved Ring Gasket For API Flanges

Internal pressures increase sealing effect; contact areas increased; more resistant to vibration

Fig. 1. **New self sealing ring** looks similar to octagonal API ring gasket and costs only slightly more.

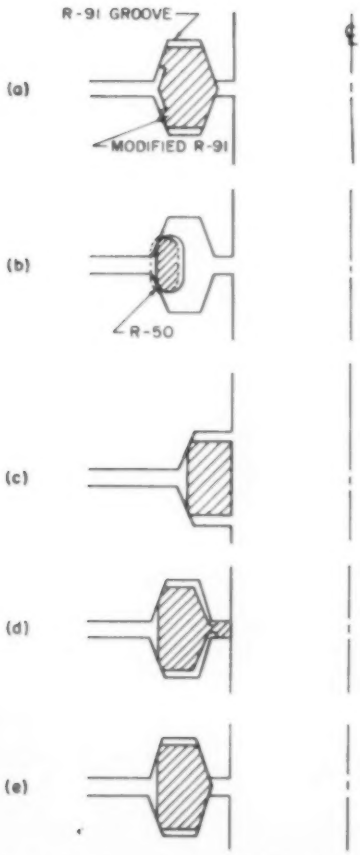

Fig. 2. **Development from API ring gasket** to new gasket design progressed through many stages. Each new cross section incorporated self-energizing seal principle. Major task was finding final field design.

A new seal ring for API flanges providing several improvements over the conventional API ring gasket has been made available to the petroleum industry. Not a ring gasket manufacturer, Cameron Iron Works, Inc., who developed the improved ring, has turned its design over to the petroleum industry on a royalty-free, patent-free basis. Fitting the standard API ring groove, it is anticipated that it may be added to standards as an API alternate ring gasket. Improvements include greater stability under compression loads and increased seal dependability.

In cross section, the new gasket is higher than conventional octagonal or oval rings and is provided with sealing flats on both inner and outer surfaces. Outside diameter of ring is slightly larger than the ring groove. Design is such that as flanges are made up, interference is obtained between the ring and wall of the ring groove. Resulting compressional force plus a 3:1 area ratio between outer sealing surface and ring height provides self sealing characteristic of the ring. Further make up of flanges engage the large tapered surfaces on the inner face of the ring for a positive internal gasket seal. Large surfaces give the resulting connection increased compressional strength plus stability and rigidity. Even with the slightly thicker design, standard API stud bolt length is used.

Ring Is Sideline Design

This new ring gasket actually resulted for work in developing 15,000 psi working pressure equipment. Realizing that high pressure equipment required equally rated connections, a study was initiated with tests on API flanges. Pressure tests performed on API 10,000 psi flange connections showed that bolt make-up stresses correlated with pressure held. Occasionally, however, slightly higher pressures could be held. Examination indicated that some self sealing tendency of the ring caused this deviation. To heighten this effect, an R-91 octagonal gasket was relieved as shown in Fig. 2(a). Tests made on modified R-91 rings showed increased pressure holding capacity at high pressure with reduced bolt stresses. Optimum face cross section to overall ring height was found to be 3-to-1 at 15,000 psi.

To further study effect, the R-91 ring gasket was replaced with an oval API R-50 gasket. This ring has a pitch diameter of $10\frac{5}{8}$-in. which provided approximately $\frac{1}{8}$-in. of interference with the outer surfaces of the ring grooves [Fig. 2(b)]. Performing like an O-ring, it verified the sealing performance possible with self-energized seals. The seal was maintained even though flanges were made up only hand tight.

Further modification of this ring is shown in Fig. 2(c) in which the gasket was made from a rectangular ring and used in a reduced diameter ring groove preparation. This was not totally satisfactory for field use due to the close tolerances required. Subsequent designs were developed for API flanges incorporating the self sealing concept. An

inner section was designed to take the weight of the flanges plus providing for the exclusion of corrosive liquids and gases. Due to the close tolerances required and greater expense of almost three times that of the API ring, it was considered applicable only to high pressure installations.

Resultant modification to present design provided a ring that gives equal seal reliability with lower cost and less need for high precision. Cost of manufacturing this new ring is approximately equal to that of the API ring.

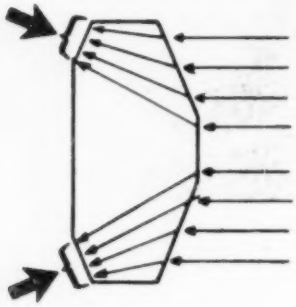

Fig. 3. **"Self-Sealing" ring gasket** utilizes the force of internal pressures to increase sealing effect over the two broad surfaces on its outside diameter. Contact area with flange groove is increased tremendously to give better sealing effect and much greater load carrying ability.

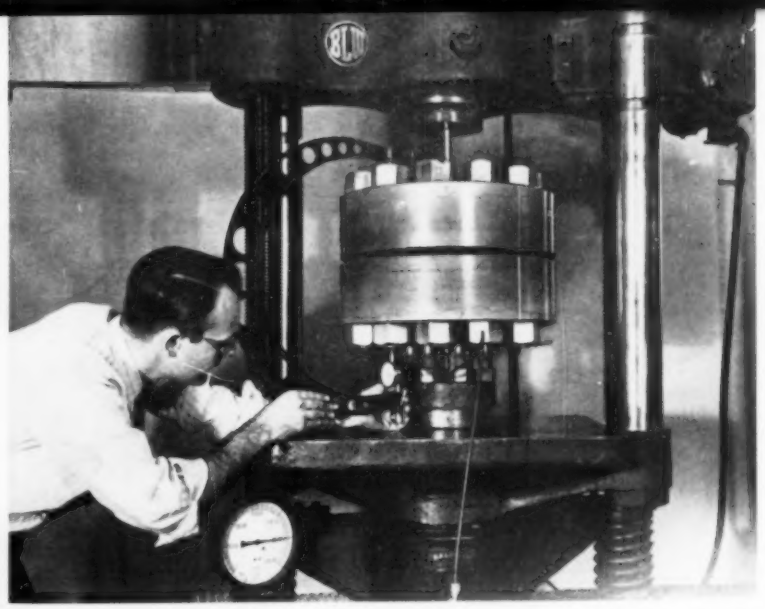

Fig 4. **Bob Brooks,** Cameron engineer, examines bolt stretch during high pressure test on flange connections.

How It Works

The self sealing ring gasket is turned with an outer tapered surface diameter slightly larger than that of the API ring groove. During make up, this face engages the wall of the groove first and due to interference results in an initial tight seal between the surfaces. Further make up of bolts engages the inner seal which acts both as a compression seal and stop for flange make up. A small bleed port is provided between the top and bottom of the ring to equalize pressures in both ring grooves. This prevents trapping grease or other fluids in the groove which might keep surfaces from proper contact. Preloading plus energized seal provides additional safety since flanges can part slightly

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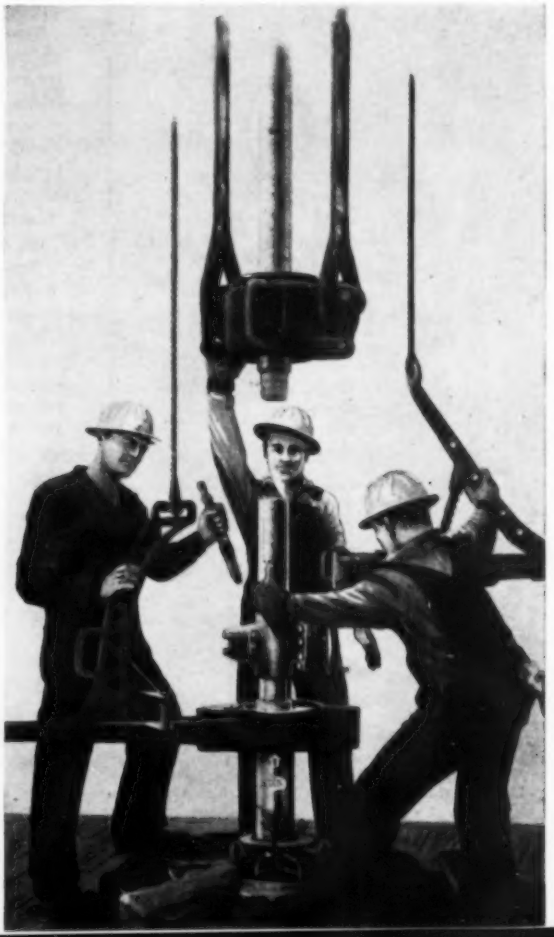

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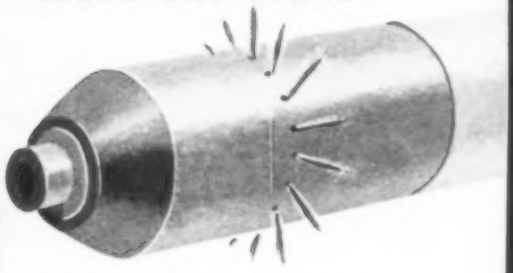

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without destroying the seal. Also, the large area of the inner seal gives additional surface for compressional loads and flange alignment.

Tests on Self Sealing Ring Gasket

A large number of tests have been performed on the improved self sealing ring gasket to compare it with the API as well as other flange sealing methods. It has been found that bolt stresses can be reduced from ½ to ⅓ of that required by conventional gasket designs with no detriment to its sealing capacities.

Among the more interesting tests were those made to examine the effect of compressional loads on ring gaskets. As an example, the following is an excerpt from a report on tests with a 12-in., 3000-psi working pressure flange.

Test. In the flange groove, install the ring gasket which is to be tested after it has been smeared with drilling mud. Install casing with the proper slips to land in the top spool. Bolt up with the 12-in., 3000 psi working pressure flange to 1100-1200 ft lb of torque on each bolt. Pressure test the ring gasket to 3000 psi. Remove pressure, wait 30 minutes and apply 3000 lb down force with the slips and hold for five minutes. Remove this load and again pressure test the seal to 3000 psi. When disassembling the unit note the torque requirements to break the flange bolts.

Results. 1. API R-57 oval gasket test. The oval gasket test proceeded satisfactorily until the 600,000-lb load was applied. After the load was removed, the flange leaked and the bolts were hand loose. Gasket and groove were scored and pitted from the loading.

2. New self sealing ring No. 186795-57. There was no leak at any time in the test. Space between flanges made up was .750 in. At the conclusion of the test, the torque required to loosen flange bolts was approximately 750 ft lb.

3. API R-57 octagonal gasket test. The octagonal ring gasket survived the test without leaking. At the conclusion of the test, torque required to unbolt flanges was approximately 1200 ft lb.

The new ring design showed considerable improvement over the oval ring and approximately the same performance as the octagonal ring. However, sealing was performed with somewhat less bolt stress through part of the test.

Due to reduced bolt stress, it is possible that flanges could be up-rated one step, i.e., 3000 psi flanges could be used up to 5000 psi. However, it has been pointed out by design engineers that this would virtually eliminate the gasket type seal and would greatly reduce the safety-plus advantage of the self sealing feature. In view of this, the ring should be considered only as a replacement for the API ring, and flange ratings should not be increased in anyway.

Major Advantage in Drilling

Greatest advantage is found in drilling applications where vibration as well as compressional loads are encountered. With the standard API gasket, compressional loads and some vibrational loads resulted in added deformation of the ring gasket. Since the gasket functions by compression loading only, rings were found to leak under pressure if stud bolts were not periodically tightened. Due to the self-energized seal and larger surface of the new, these forces are found to have no effect on the self sealing ring. Self sealing rings are available from a number of manufacturers at this time in large sizes for API 2000 to 10,000 psi flanges. It is anticipated that sizes will be available in the near future to meet all API flange specifications.

Acknowledgment

We are indebted to Cameron Iron Works, Inc., for data and illustrations used in this engineering report. ★ ★ ★

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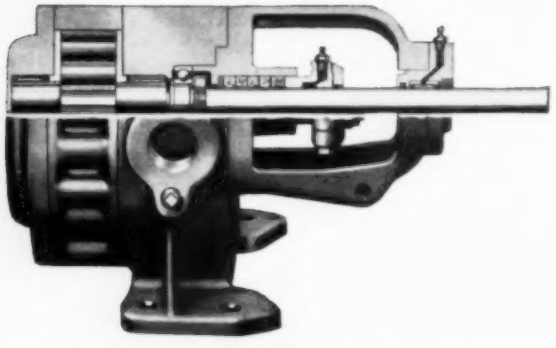

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Kilgore, Powell Picked as 1957 PESA Leaders

Grover Kilgore

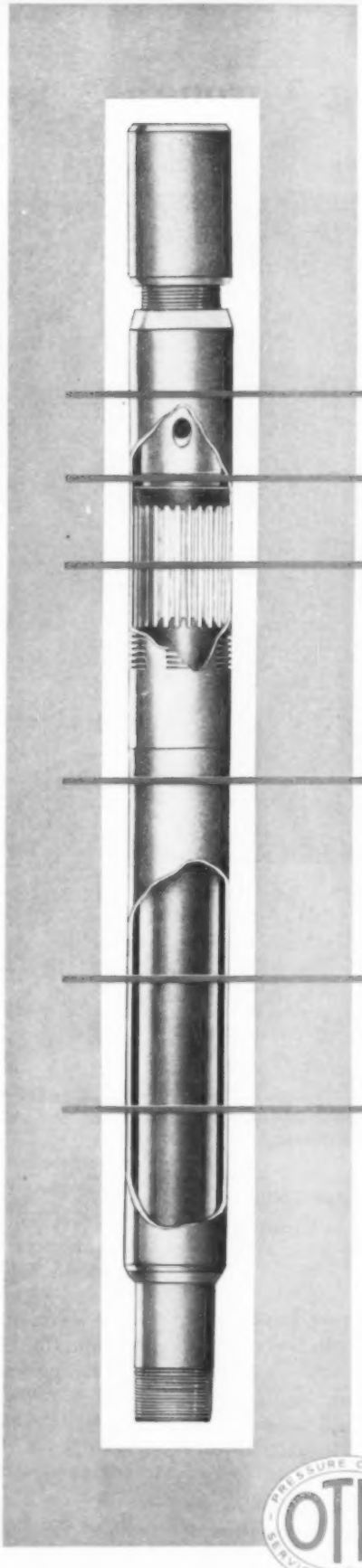
W. T. Powell

Petroleum Equipment Suppliers Association has elected Grover Kilgore of Halliburton Oil Well Cementing Company, Duncan, Oklahoma, as its president for the coming year. W. T. Powell of Continental-Emsco Company, Los Angeles, California, was named vice president.

Other officers elected during the PESA's twenty-second annual meeting in Palm Springs, California, include: Wharton Weems of Vinson, Elkins, Weems & Searles, Houston, Texas, treasurer; LeRoy Jeffers of the same firm, assistant treasurer, and H. R. Safford Jr., Houston, executive secretary. These three officers were re-elected to the same posts held last year.

Former president of the supplier's organization was Rainey Elliot, president of Jones & Laughlin Steel Corporation, supply division.

Chairmen of the four districts, also acting as directors of the group are: Powell, for the Pacific district; M. E. Montrose of Hughes Tool Company, for the Southwestern district; John G. Staudt of Dowell Inc., for the Mid-Continent and Rocky Mountain district, and Paul Scherf of Alten Foundry & Machine Works, Inc., for the Eastern district.



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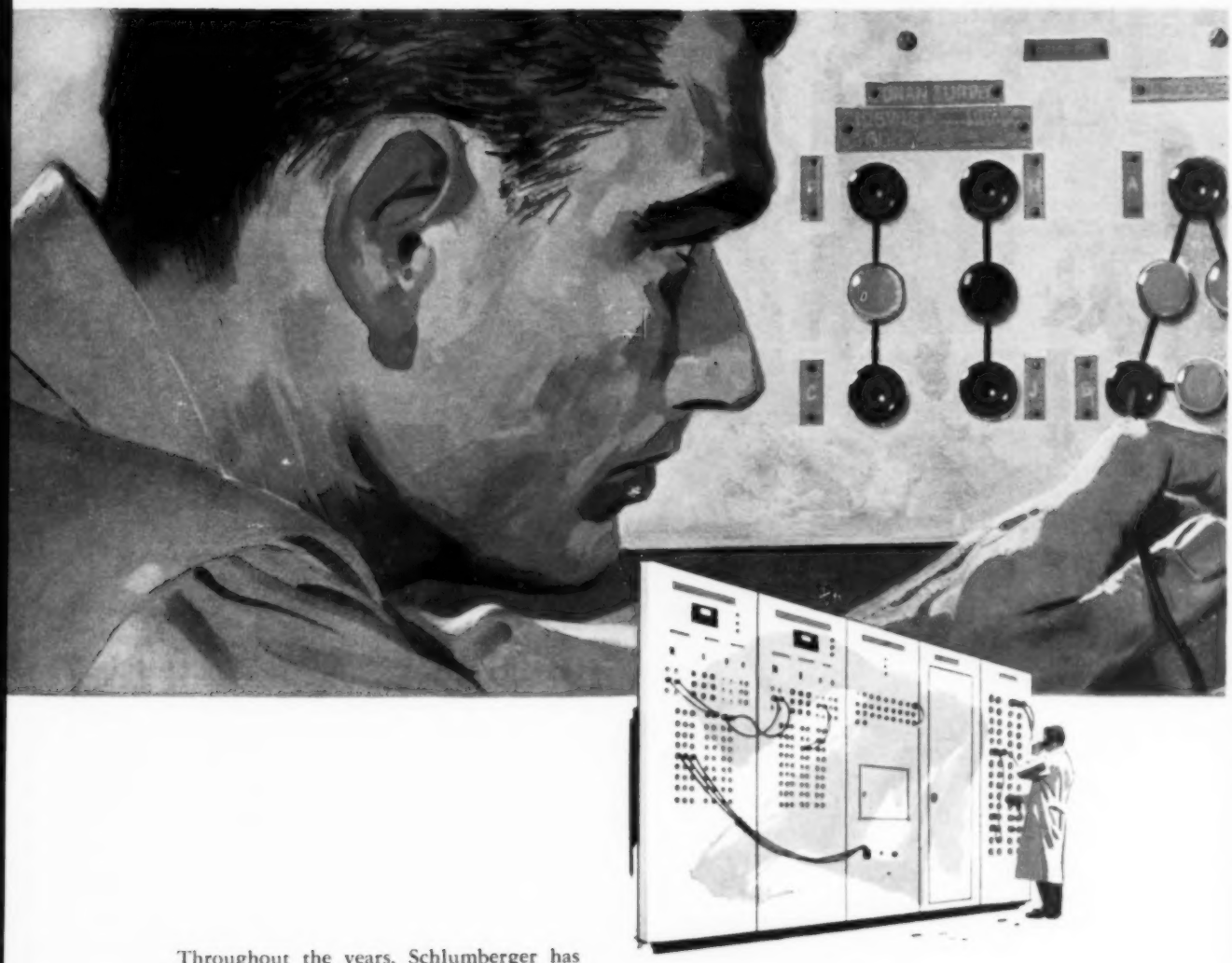

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To aid in this work, engineers at the Schlumberger plant in Houston conduct simulated field tests from their laboratory benches. Each laboratory is wired to a common test well with standard logging cable. A "flick of the switch" in a distribution center connects the logging instrument in the well with the surface recording equipment in the laboratory. This "logging through a switchboard" illustrates the progressive engineering practices utilized at Schlumberger.

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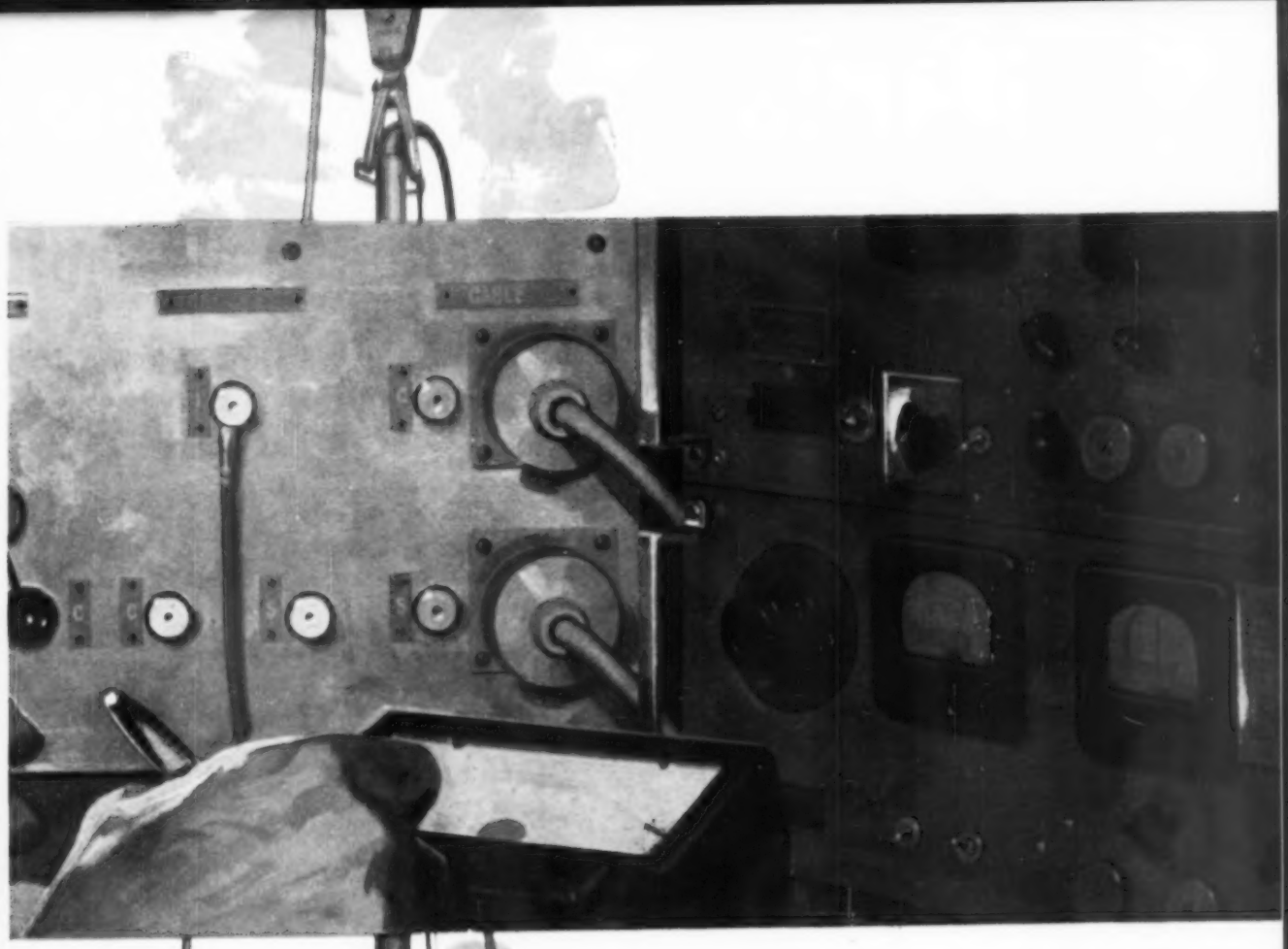

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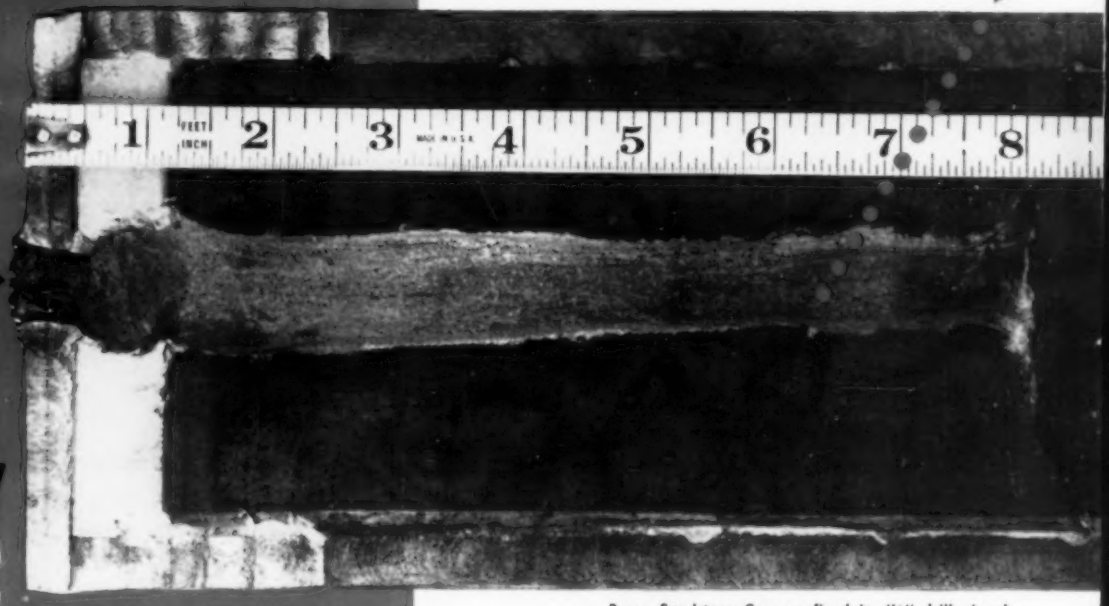

Berea Sandstone Core confined in 4½" drill pipe by ¾" Hydromite and ⅜" mild steel head-plate.

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Laboratory Drilling of Gulf Coast Shales Shows . . .

How Mud Properties Affect Drilling Rate

R. A. Cunningham,
Hughes Tool Company, Houston, Texas

W. C. Goins, Jr.,
Gulf Oil Corporation, Houston, Texas

Oil added to a lime base mud reduces bit balling and increases drilling rate in this tough and gummy formation. Reduced fluid loss resulted in reduced drilling rates

OIL added to a lime base mud increased drilling rates in Gulf Coast shales as much as 150 percent with increased oil content up to 15 or 20 percent, and materially reduced bit balling. Lowering fluid loss properties from 13.4 cc to 2.4 cc by adding starch reduced drilling rates about 20 percent. It was found that soft shales are kneaded by the bit rather than fractured. The kneaded material is mixed with water or mud to a thick paste, which in severe cases extrudes up around the bit to cause severe balling. Presence of this kneaded mass is a function of the formation, drilling fluid and action of the bit jets.

These were the principal findings of a special study on laboratory drilling of Gulf Coast shales to determine: (1) Effect of oil content in a lime base mud on drilling rates; and (2) effect of water loss on drilling rates. Advantages of oil emulsion muds based on field experiences have been reported by Weichert and Van Dyke[1] and Perkins.[2]

What affects drilling rate? Neglecting all problems at the surface and considering only the conditions at the hole bottom, the following factors directly affect drilling rate, bit life and hole cost:

1. Drilling Bit
   a. weight on bit
   b. rpm
   c. cutting structure
2. Circulating Fluid
   a. Dynamic Properties
      1. velocity
      2. Circulation rate
   b. Intrinsic Properties
      1. density
      2. viscosity
      3. fluid loss
      4. composition
3. Formation
   a. strength
   b. abrasiveness
   c. "brittleness," "toughness"
   d. physical state
      1. permeability
      2. interstitial pressure
      3. fluid column pressure
      4. overburden pressure
      5. temperature

Based on a report by the authors to the Drilling Fluids Study Committee of the Southern District, API Division of Production at Shreveport, Louisiana, March 20-22, 1957, and originally titled "Laboratory Drilling of Gulf Coast Shales."

These factors are not necessarily independent of each other. The effect of jets, for example, depends on the type of formation. It is different in a Gulf Coast shale than in a hard quartzite.

Advantage of laboratory drilling. Effects of circulating fluid properties on rate of penetration are of prime interest, but determination of these in field operation is complicated by the other factors. It is almost impossible to have the same conditions of formation, rig equipment, crews, hole depth, bits, bit weights, etc., in any two wells so that the influence of any one factor may be determined. Therefore, evaluation of the effect of a mud property is usually possible only through tests in a large number of wells so that the influence of other factors can be eliminated statistically.

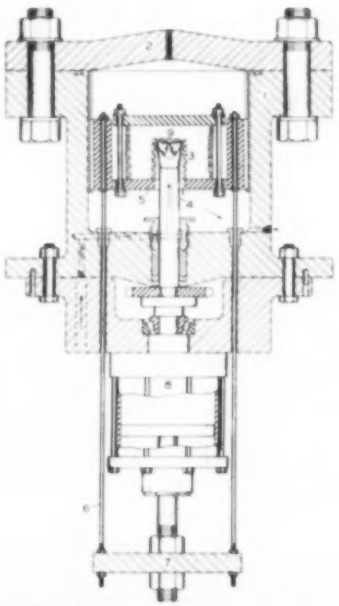


FIG. 1. **Drilling chamber** of high-pressure drilling equipment.

One approach to this problem is the use of the microbit drilling machine. With this equipment, more experimental variables can be tested in a minimum of time. More control can be exerted over those items to be held constant as well as the variables. Closer observation of the bit, formation and drilling fluid is possible.

Drilling test hookup. Drilling equipment is built around a drilling chamber, Fig. 1, designed for high-pressure drilling. Drilling fluid is maintained at a test pressure within the confines of the drilling chamber (1) and (2). A 1¼-in. diameter rock bit (3) of Fig. 1 and Fig. 2 is mounted on a drill stem (4) within the chamber. A 2 to 5-in. diameter by 2½-in. long formation core (9) is mounted in a specimen holder (5). This specimen holder with the rock moves in a vertical direction. Bit load is applied by an air cylinder (8) through connecting members (7) and (6) to the specimen holder (5). An additional load is applied by the pressure in the chamber pushing against the rods (6).

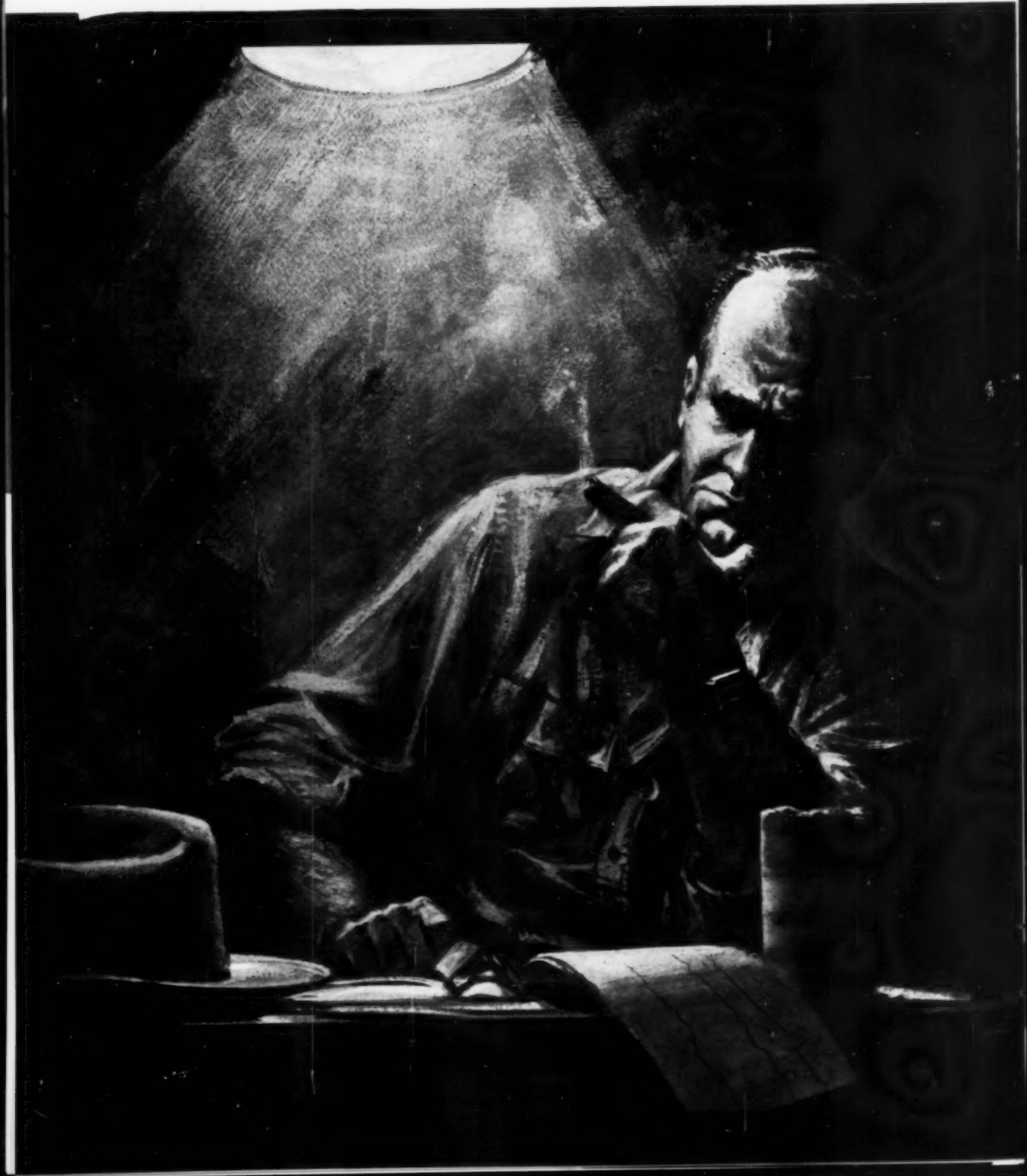
"Chips" formed are removed by fluid entering the vessel from an external source and moving as indicated by the arrows through the drill stem and bit. The circulating system is closed with a pump circulating volumes as high as 12 gal per min within a pressurized system. Pressure is maintained in the entire system by a high-pressure, chemical injection pump capable of maintaining a maximum of 14,000 psi.

The bit, Fig. 2, is a 1¼-in. diameter two cutter bit with two 5/64-in. diameter jets. Jet velocities as high as 265 ft per sec have been attained.

Shale cores used. Cores for the tests

Source A - subsurface data indicates oil

Source B - subsurface data indicates water



What to do?

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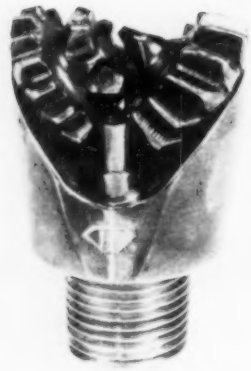


FIG. 2. **Microbit** used in shale drilling tests. It is 1¼-in. in diameter, has two 5/64-in. diameter jets.

were either canned, wrapped and boxed, or sealed in lucite tubes as soon as taken to prevent drying. Because of "ringtail" spalling, outside of the cores was irregular in shape. In order to prevent disintegration during drilling and to provide an easily mounted specimen, pieces of the shale cores were placed in cylindrical waxed cardboard containers and set in cement or plaster of paris. Each core piece was then cut into 3-in. lengths and sealed in cans until drilled.

Drilling fluids used. Drilling fluids used for these tests were conventional lime muds. In order to reduce the number of variables which could have an effect on the rate of penetration, all mud properties except the one being studied were held as nearly constant as possible throughout each series of tests.

TABLE 1 — Test No. 1
Properties of Muds Used for Rate of Penetration Tests
Effect of Oil Content on Rate of Penetration

Mud No.	"Pf" Alkalinity	FANN PROPERTIES AV	PV	YP	Initial Gel.	10 Min. Gel.	Density (ppg)	API Fluid Loss (ml)	cake (in.)	Oil Content % By Volume	Solids % By Volume
1	6.8	25.5	25	1.0	1	2	13.4	10.6	3/32	0	20.2
2	5.2	28.3	27	2.5	1	1	13.4	10.6	5/32	15	20.6
3	5.9	26.5	27	−1	1	5	13.4	9.8	3/32	5	19.8
4	7.2	27.5	28	−1	1	8	13.4	8.0	3/32	10	19.7
4-A*	6.3	23.5	24	−1	1	1	13.4	5.3	2/32	10	19.7
5	4.4	33	31	4	1	1	13.4	11.4	8/32	25	20.5
6**	8.6	24.5	26	−3	0.5	1	13.4	6.2	3/32	10	19.7

TABLE 2 — Test No. 2

Mud No.	"Pf" Alkalinity	FANN PROPERTIES AV	PV	YP	Initial Gel.	10 Min. Gel.	Density (ppg)	API Fluid Loss (ml)	cake (in.)	Oil Content % By Volume	Solids % By Volume
7	5.2	34.5	33	3	0.5	3	13.8	7.0	2/32	0	20.3
8	6.1	37.5	36	3	0.5	1	13.3	5.2	2/32	5	20.5
9	5.0	39	36	6	0.5	1	13.8	6.6	2/32	10	20.8
10	7.2	34	34	0	0.5	1	13.8	5.6	2/32	15	20.7
11	6.5	47	42	10	0.5	1	14.0	3.6	2/32	25	21.0

*4-A — Emulsifier "A" added to mud #4 after running 10% oil test.
**Duplicate of mud #4 with emulsifier "B" added.
Units AV — centipoise, PV — centipoise, YP — lb/100 ft.²

TABLE 3 — Test No. 3
Properties of Muds Used for Rate of Penetration Tests
Effect of Fluid Loss of Penetration

Mud No.	"Pf" Alkalinity	FANN PROPERTIES AV	PV	YP	Initial Gel.	10 Min. Gel.	Density (ppg)	API Fluid Loss (ml)	Cake (in.)	Solids Content % By Volume
12	7.9	35.5	31	9.0	2	57	13.4	13.2	1/32	20.0
13	6.8	41.3	37	9.5	1	18	13.4	7.2	3/32	20.0
14	6.8	39.0	35	8.0	1	2	13.4	3.4	115/32	19.8
15	5.4	43.3	37	12.5	1.5	12	13.4	2.4	1/32	19.8

Units AV — centipoise, PV — centipoise, YP — lb/100 ft.²

Core Description

Test No.	Formation	Depth	Field	State	Size
1	Vicksburg	7925–75	Pierce Junction	Texas	4½ in.
2	Miocene	8000–40	Timbalier Bay	Louisiana	4½ in.
3	Wilcox	8331–55	West Mission Valley	Texas	4½ in.

Properties of muds used are shown in Tables 1, 2 and 3. Their compositions are listed in Table 4.

Testing procedure. Core samples were subjected to a uniform hydrostatic pressure acting on all external surfaces by the drilling fluid. "External surfaces" include the drilled hole surfaces as they are generated. Hydrostatic (or

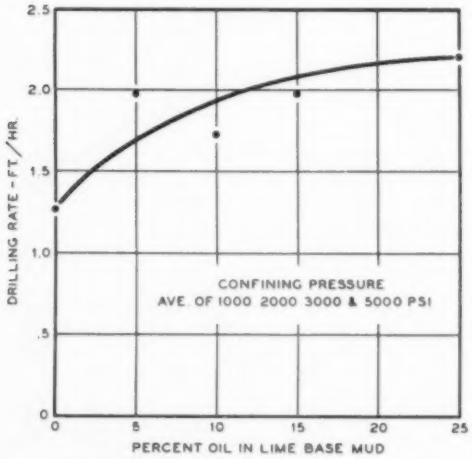


FIG. 3. **Drilling rate vs percent oil** under following conditions: jets, 215 ft/sec; 250 lb bit weight; 50 rpm; Vicksburg shale from Pierce Junction field, Texas. Each point is an average of 6 tests.

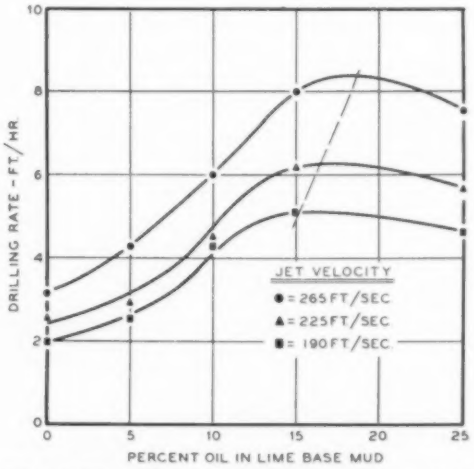
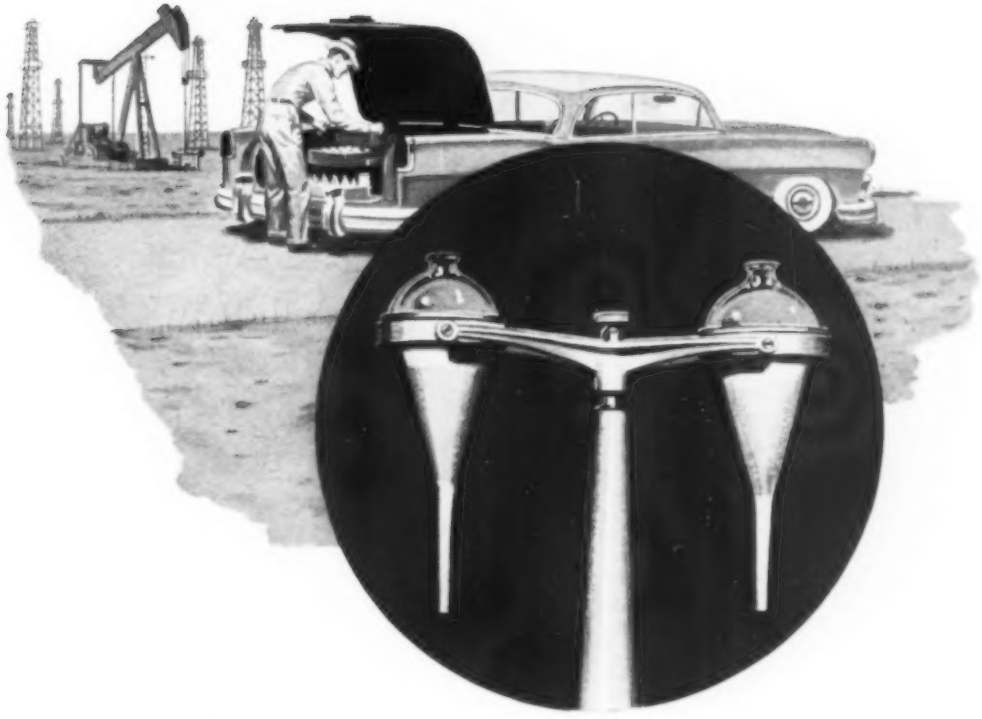


FIG. 4. **Drilling rate vs percent oil** in a Miocene shale from Louisiana. Bit was 1¼-in., 2-cone jet, with 500 lb weight and 50 rpm. Hydrostatic pressure was 5000 psi. Each point is average of 16 tests.



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confining) pressure was used for two reasons: (1) Pressure placed the rock in a condition more nearly like down hole conditions than testing under atmospheric conditions, and (2) the compressing effect of pressure produced a stronger and more uniform material. While this confining pressure was maintained, drilling proceeded and drilling rate was determined as a function of mud properties.

Effects of pressure on physical properties and drilling rates of different rocks have been shown in previous investigations. Jacketed rock cylinders exhibit an increase in compressive strength with confining pressure as shown by Adams,[3] Handlin,[4] Bredthauer[5] and others. Unjacketed but nearly impermeable core samples demonstrate a decrease in drilling rate with increased confining pressure under laboratory drilling conditions.[6] In general,

TABLE 4
Composition of Mud Used for Rate of Penetration Tests

Mud No.	Water	Bentonite	Low Yield Clay	Barite	Caustic	Quebracho	Lime	Fluid Loss Agent	Oil
1	79.5	8.9	27.5	328	3.2	2.8	7.5	1.3	0
2	67.5	6.7	21.0	410	3.2	2.8	7.5	0.9	15
3	67.5	7.5	21.0	359	3.2	3.2	8.0	1.1	5
4	67.5	7.0	21.0	374	3.4	3.4	8.0	0.8	10
4-A	67.5	7.0	21.0	374	3.4	3.4	8.0	0.8	10
5	54.5	7.6	23.4	536	3.0	3.0	8.0	1.0	25
6	67.5	7.0	21.0	374	3.4	3.4	8.0	0.8	10
7	79.5	8.9	27.5	328	3.2	5.3	7.5	1.3	0
8	75.0	10.5	21.0	364	3.2	2.8	7.5	1.1	5
9	68.5	12.0	21.0	398	3.3	2.8	8.0	0.3	10
10	64.5	10.0	21.0	423	3.0	2.8	8.0	0.4	15
11	54.5	10.0	21.0	543	3.0	2.8	8.0	0.2	25
12	79.4	12.9	30.9	315	4.4	5.0	10.0	0	0
13	79.4	12.9	30.9	315	4.4	5.0	10.0	2.5	0
14	79.6	9.96	30.9	315	4.4	6.3	10.0	5.0	0
15	79.6	9.96	30.8	315	4.4	6.6	10.0	6.4	0
16	69	11.6	30.2	384	4.2	4.8	9.5	2.1	10.6
17	69	11.6	30.2	384	4.2	4.8	9.5	2.1	10.6
18	69	11.6	30.2	384	4.2	4.8	9.5	2.1	10.6
19	68.5	12.0	21.0	398	3.3	2.8	8.0	0.3	10
20	68.5	12.0	21.0	398	3.3	2.8	8.0	0.3	10
21	68.5	12.0	21.0	398	3.3	2.8	8.0	0.3	10

Water and oil are volume percent of final mud. All other additions are lb/bbl of water.

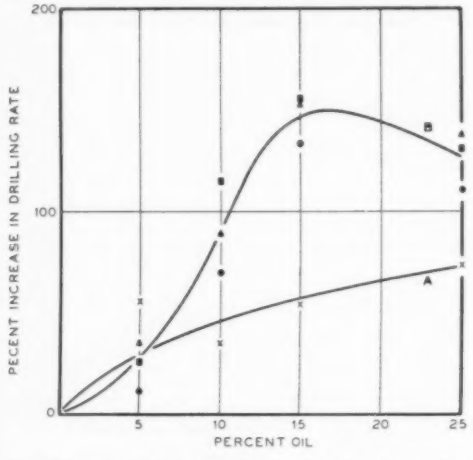

FIG. 5. **Increase in drilling rate** vs oil concentration while drilling two different types of shale. Curve A is for a Vicksburg shale; Curve B is for a Miocene shale.

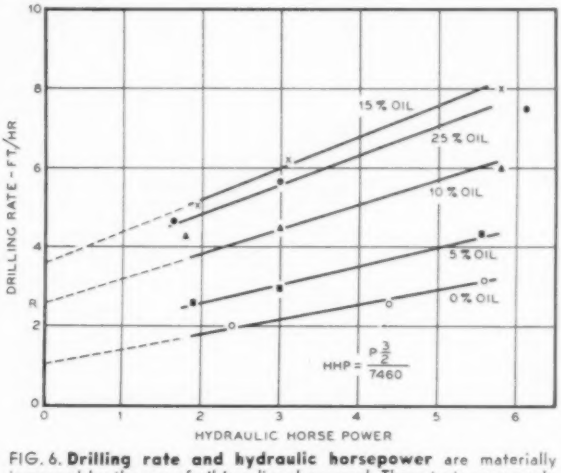

FIG. 6. **Drilling rate and hydraulic horsepower** are materially improved by the use of oil in a lime base mud. These tests were made on a Miocene shale with 5/64-in. jets, a 13.4 lb/gal mud, a bit weight of 500 lb and bit speed of 50 rpm. Hydrostatic pressure was 5000 psi. Each point is average of 16 tests.

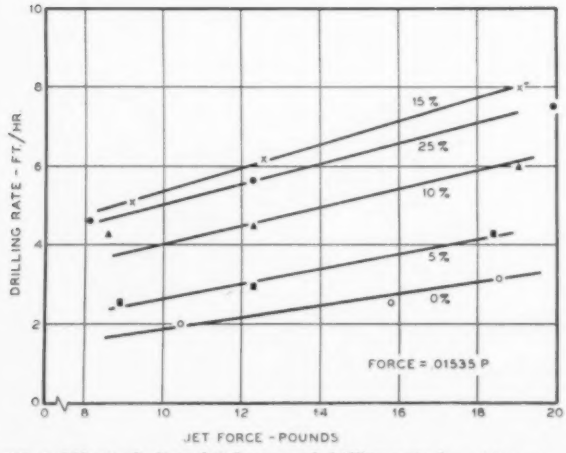

FIG. 7. **Effect of oil on jet force and drilling rate** for a Miocene shale. Each point is average of 16 tests. Mud weight: 13.4 lb/gal; 5/64-in. diameter jets; bit weight, 500 lb and 50 rpm; hydrostatic pressure, 5000 psi.

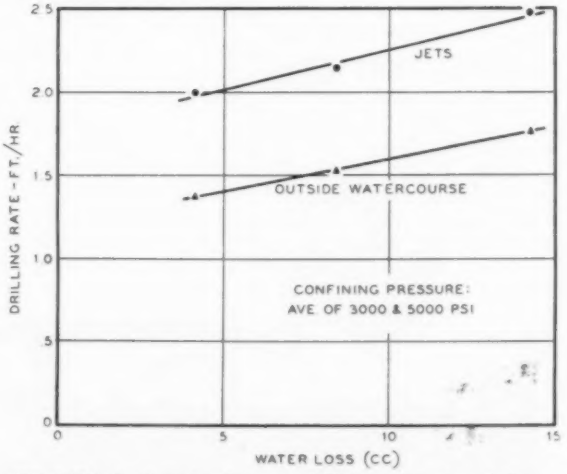

FIG. 8. **Effect of water loss on drilling rates** when drilling a Wilcox shale with a 11/2-in. bit in a lime base mud. Bit weight: 750 lb; speed: 50 rpm. Each point is average of 24 tests.

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this decrease in drilling rate is proportionately greater in soft shales than in harder formations.

The present series of tests were started with pressure of 0, 500, 1000, 2000, 3000 and 5000 psig only to be sure the test variables reacted the same under different pressures. Scatter was excessive at 0 and 500 psig resulting in data of little value. Results obtained with 1000, 2000, 3000 and 5000 psig showed that pressure only shifted the drilling rate curve down with increasing pressure. Tests were then altered to use only 3000 and 5000 psig and later only 5000 psig.

Testing formation cores of this type requires two considerations for proper sampling. One, samples must be taken throughout a section to be representative of the section. Two, enough tests at each condition must be made so that a statistical average represents the effects of the variables tested. Each value reported in these tests is an average of 6 to 20 tests. They were designed so that each test condition would contain samples from points scattered throughout the total length of the core.

Bit weight was varied with different shales, from 250 lb to 750 lb on a 1¼-in. diameter bit. Experience has shown that for this laboratory equipment, one to 15 ft per hr drilling rate gives the best test conditions. Bit weights were adjusted to hold results within this range.

Two complete series of tests were made varying the oil content in the mud as follows: 0, 5, 10, 15 and 25 percent. By necessity the first series of tests was used in working out procedures and practices. During the second series of tests, better use of available material was made, with the result that conditions under three different fluid volumes were used: 8.1, 6.8, and 5.6 gal per min. Two 5/64-in. diameter nozzles were used throughout the tests resulting in approximately 265, 225 and 190 ft per sec jet velocities.

One series of tests was made varying fluid loss properties of the mud. This varied from 2.4 to 13.2 cc.

Results of Drilling Tests

1. Variation in oil content. Separate tests were made using two different shales. Both tests indicated improvements in drilling rates that can be obtained with added oil. In these tests there are no friction losses between the drill stem and the wall of the hole that can hold back bit weight. Any improvements, therefore, occur at the bit.

Results of test No. 1 are shown in Fig. 3. Conditions of the test were: Jet velocity, 215 ft per sec; bit weight, 250 lb; 50 rpm. Each point is an average of values obtained at 1000, 2000, 3000

FIG. 9. **Condition of filter** after drilling 9 tests with a lime base mud containing 15 percent oil, showing relatively little shale removed.

FIG. 10. **Lime base mud with 25 percent oil** removes considerably more shale as indicated by the filter after drilling 9 tests.

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and 5000 psi confining pressure, on Vicksburg shale from Pierce Junction, Texas. Irregularities in points result in part from early test procedures, but the effect of oil content in the mud is evident. Five percent of oil caused a large increase in drilling rate. Twenty-five percent resulted in a continuing increase.

Results of test No. 2 are shown in Fig. 4. Test conditions were: Jet velocities, 265, 225 and 190 ft per sec; bit weight, 500 lb; 50 rpm; confining pressure 5000 psig; Miocene shale, Timbalier Bay, Louisiana. Drilling rate increased with increased oil to an oil content of between 15 and 25 percent. Twenty-five percent was definitely beyond the optimum oil content. Occurrence of an optimum oil content is in agreement with observations by Eckel,[7] in some West Texas drilling. At 15 percent oil, the drilling rates were about 150 percent greater than with no oil. As would be expected, drilling rate is faster for higher jet velocity and flow rate.

If data of the two preceeding tests are plotted together as Percent Increase In Drilling Rate vs Percent Oil, the first group of tests (Curve A, Fig. 5) indicate that 5 percent oil increases drilling rate markedly while succeeding increases in oil show smaller increases. The second test (Curve B is an average for three different jet velocities) shows that improvement in drilling rates are obtained with oil up to 15 percent or more and a further increase to 25 percent actually decreases drilling rate. Because of the experience and better planning that went into test No. 2, results are considered to be more significant.

From Fig. 4, there is an indication that the optimum oil content may vary slightly with the dynamic properties of the mud as shown by the dashed line drawn through the maximum points on the curves. It may also be inferred from Fig. 5 that drilling rates in one shale may improve more with oil added than in another shale. At present, the validity of these observations must remain subject to further testing.

Effect of hydraulic horsepower. Although secondary to the purpose of the test, it is of interest to use this information to plot drilling rate as a function of other quantities than can be determined. Possibly the two quantities of most interest are hydraulic horsepower and force of the jet stream, and a comparison of their effect on drilling rate was made. Fundamental data is limited because only three flow rates and constant nozzle diameter were used. The pressure drop across the bit was measured and used to calculate volume rate of flow, hydraulic horsepower and jet force directly. Equations used are given in the Appendix.

Fig. 6 shows Drilling Rate vs HHP with Percent Oil as a parameter. The family of straight lines as shown appears to represent the data. These can be represented by:

Drilling Rate $= R_o + (M)(HHP)$

Where:

R_o is the intercept with the ordinate

M is the slope of the line

R_o is then some measure of the cutting ability of the bit. M is a measure of the effect of fluid action on drilling rate. Calculation of R_o and M are below. The addition of oil enables the bit to do its work better as R_o increases. The addition of oil also enables the drilling fluid to do its work better as M increases. The percentage increase in R_o is greater than the percentage increase in M indicating the addition of oil helps the bit action more than it helps the fluid. As will be seen later, bit balling may be one reason why R_o varies with oil content.

Continuous force of the jet (deflected 90°) contains the product of flow rate and jet velocity (Appendix B) which Eckel and Nolley,[7] as a

Calculation of R_o and M.

% Oil Content	0	5	10	15	25
R_o	1.06	1.64	2.38	3.60	3.32
M	.068	.466	.624	.706	.746

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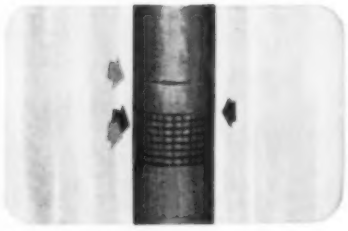
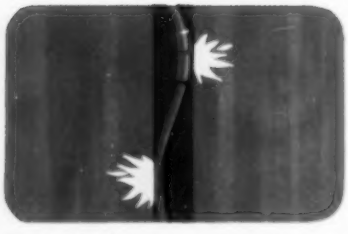


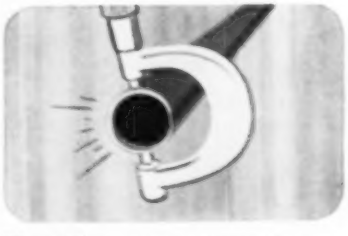
Notch Fatigue (Slip Wear)—Transverse notches, such as those caused by slip teeth can make even relatively new pipe fail. Crosswise notches and scars are natural stress raisers and are an open invitation to failure and fishing jobs.

Corrosion Fatigue—Corrosion fatigue is one of the most common causes of drill pipe failure. Pipe becomes pitted. Pits become stress raisers as pipe bends. Cracks develop. Joints deeply pitted are usually unsafe.



Crooked Pipe—Running pipe in compression, dropping pipe while pulling up or laying down joints, or careless handling during transportation can crook pipe. Crooked pipe is more likely to fail from fatigue, and accelerates wear on tool joints.

"Necked Down" Pipe—Using tongs on the body of the pipe or careless setting in the slips when tripping heavy strings can crush the pipe. Pulling too hard on stuck pipe will cause it to neck down.



Worn Pipe—The straightest pipe wears. Crooked pipe wears lopsided. Depth of well to be drilled, corrosion and other factors affect how hard pipe is stressed and, consequently, how thin it can be worn before it is dangerous to run.

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result of study of work reported by Nolley, Cannon and Ragland,[3] report to be proportional to drilling rate for drag bits. Fig. 7 shows Drilling Rate vs Force of the Jet with percent oil content as a parameter. Again a family of straight lines appears to represent the results.

2. Variation of fluid loss properties. Results of test No. 3 using muds with varying water loss properties are shown in Fig. 8. Fluid loss varied from 2.4 cc to 13.4 cc. The mud description was given earlier. Decreasing fluid loss resulted in a decrease in drilling rate. Comparing the drilling rate using 2.9 cc with 13.4 cc, the decrease is about 20 percent and appears linear in between. (The 2.9 is an average of 2.4 cc and 3.4 cc, results of which were averaged.)

It is difficult to understand what effect fluid loss can have on an almost impermeable material. Perhaps the answer is the "almost" and the fact that new bottom is being uncovered continually. It is possible that a minute filter cake is laid down on newly uncovered bottom because the filtrate tends to move into the "almost" impermeable shale or into minute cracks. This would tend to hold the formation in place as long as a pressure drop remained across the filter cake.

Another possibility lies in the materials used to decrease the fluid loss. The starch content varied from 0 for the 13.4 cc mud to 6 lb per bbl for the 2.4 cc mud. If a little oil in mud can change the drilling rates, surely variations in starch or other materials can also affect drilling rate. Possibly it is this variation that is reflected in the test results rather than the fluid loss.

3. Effect of emulsifiers. Limited work has been done on the effect of using emulsifiers with oil. In all cases a mud with 10 percent oil plus an emulsifier was compared with a mud containing 10 percent oil. In one formation under one set of jet conditions, one emulsifier showed about a 25 percent improvement in drilling rates. Under other jet conditions or on other formations no improvement was observed in these tests. In many cases the data were not complete enough to draw any sound conclusions.

4. Use of water. Water as a drilling fluid was used to compare with lime base muds in Vicksburg shale. The water contained 10 percent rust inhibitor. Previous tests indicated that the rust inhibitor had no appreciable effect on drilling rates. Bit weight, jet velocities and rpm were equal with both water and mud (250 lb, 220 ft per sec and 50 rpm respectively). Drilling rates with water were about 5 to 15 times as large as with mud. With water, the hole was enlarged and irregular in shape. With mud, gage hole was maintained.

Why oil reduces balling. Severe balling of the bit was an early problem. As a result, some studies of the causes and effect of oil content on balling were made. The effect of oil content on bit balling was most pronounced in test No. 2 described earlier and the results shown in Fig. 4. Balling occurred in varying degrees from no balling to very heavy balling. For the purpose of comparing each test, these were listed as either balled or not balled. The percentage of balled bits in tests at each oil content is listed in the following table:

Percent oil content	0	5	10	15	25
Percent balled bits	100	89	56	22	11

With increased oil, balling decreased. The drilling rate was maximum at about 15 percent oil but balling continued to decrease with added oil.

In this test, oil apparently had the effect of keeping the tiny shale particles apart, preventing them from sticking together or sticking to the bit. From this standpoint the ideal fluid would be one which would keep the shale in a powdery or granular form.

This effect was noted again in the filter which was a 40 mesh wire screen. After each test was completed, mud was cleaned out of the equipment and the filter removed and cleaned. After the tests with 0, 5 and 10 percent oil, the filter screen was covered with a thick layer of shale paste which was difficult to remove. With 15 percent oil, the shale had fallen to the bottom of the container and the screen was clean as shown in Fig. 9. With 25 percent oil, there was shale on the screen but not

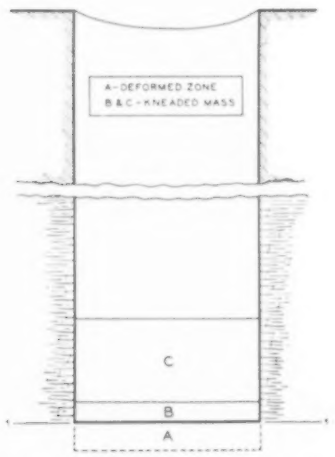

FIG. 11. **Kneaded shale** in bottom of hole during severe bit balling. Fluid enters cracks, shale becomes kneaded until water causes it to become a paste, shown as area B. Paste extrudes into area C. Shale becomes disturbed in area A. Microbit and cuttings not shown.

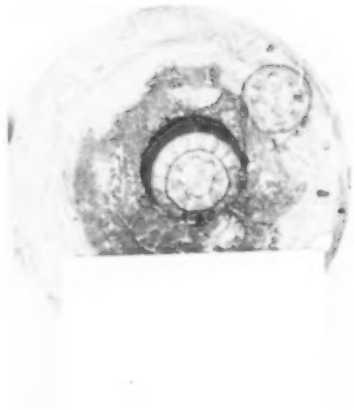

FIG. 12. **Bottom hole pattern** from first model 1½-in. jet bit. Jets cleaned a 5 16-in. wide annular area near hole wall. Center consists of kneaded shale easily lifted off bottom. One was removed from another hole and is shown in upper right.

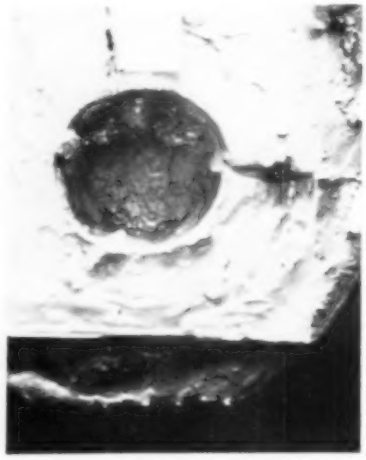

FIG. 13. **Gummy shale paste** filled a good portion of hole drilled with 1½-in. microbit in a Wilcox shale.

FIG. 14. **Microbit after drilling** hole in Fig. 13. Bit was balled so badly that hole was completely filled. Part of shale remained in hole and part came out with the bit. However, circulation appeared normal.

cemented to it as before and was easily removed, Fig. 10.

In all tests, there were sizable cuttings which came through undamaged. However, enough of the formation was ground to powder to cause the forming of a paste with its resulting effects.

Additional balling tests. Balling that occurred was the subject of additional studies. One simple test consisted of grinding a shale sample into a powder. There was water in the shale but not enough to make the particles stick together. A small amount of water was added. Immediately the shale powder absorbed enough water to make a sticky, gummy paste. Additional water did not break down this paste very well. With much working and washing this paste could finally be dispersed.

Similar effects appear in drilling with the laboratory rock bit. Fig. 11 represents a drilled hole. The rock bit is not shown. Line 1-1 represents the approximate surface on which the teeth are acting. Ahead of this surface in the region A, shale is beginning to be disturbed. Tiny openings are formed. The fluid tends to run into these openings while the solids in the mud are held back at the surface. As the bit advances, the shale becomes more kneaded until the water content causes it to become a mass that varies from a stiff putty to a sticky paste. This paste (or kneaded mass) is shown by the area B. In some extreme cases this paste may continue to extrude up around the bit as seen by C; but the paste was always present in the tests.

Presence of the sticky material in B depends on the formation, drilling fluid and jet action. In some cases jets can remove nearly all of it. One early model of a jet microbit left a portion of this paste in the center of the hole bottom as shown in Fig. 12. In one extreme case, this paste filled a good portion of the hole as in Fig. 13, with a resulting severe balling of the bit as in Fig. 14.

Water or mud plus shale, plus rock bit form the raw materials and machinery of an excellent gumbo-making factory. Apparently, the gumbo-like material is a factor in drilling — the degree varying with formation, jet action and mud properties; subject to control by variation in oil content.

Acknowledgment

The authors wish to thank Gulf Oil Corporation and Hughes Tool Company for permission to present this report and for the facilities and materials that made it possible. They are also indebted for the invaluable help of J. A. Dawson Jr., Gulf Oil Corporation and John Eenink and H. B. Woods, Hughes Tool Company.

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APPENDIX

A. Hydraulic Horsepower in terms of pressure drop across the bit.

$$HHP = \frac{GP}{1714} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

G = flow rate, gal per min
P = pressure, psi

From fundamentals of hydraulics

$$Q = C_1\, av \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

a = area of nozzle
v = velocity
C_1 = nozzle area coefficient
Q = flow rate

and

$$v = C_2 \sqrt{2g \frac{p}{\rho'}} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

C_2 = velocity coefficient
g = acceleration due to gravity
p = pressure
ρ' = density

substituting (3) into (2)

$$Q = Ca \sqrt{2g \frac{2g}{\rho'}} \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

$C = C_1 C_2$

Converting $Q = G$ = gal per min; $a = A = in^2$, $p = P =$ psi; and $\rho' = \rho =$ lb per gal (4) becomes

$$G = AC \sqrt{\frac{P}{\rho}\, 12031} \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

substituting (5) into (1) then

$$HHP = \frac{P^{\frac{3}{2}} AC}{15.64\, \rho^{\frac{1}{2}}}$$

In these tests $A = .009588\ in^2$
$\rho = 13.4$ lb per gal
assume $C = .08$

Then

$$HHP = \frac{P^{\frac{3}{2}}}{7460} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (6)$$

B. Continuous force of jet stream in terms of pressure drop across bit. From fundamental mechanics

$$F = Ma$$

F = force
M = mass
a = acceleration

Since the average rate of acceleration $a = \frac{v_2 - v_1}{t}$

then $F = M \left(\frac{v_2 - v_1}{t} \right)$

v_1 = initial velocity in direction of nozzle
v_2 = final velocity in direction of nozzle

If a continuous stream of fluid has its velocity changed from v_1 to v_2 by a hole bottom, by letting $t = 1$, the quantity $\frac{M}{t}$ becomes the mass per unit time, M. The continuous force exerted by the bottom on the fluid is then $F = M\ (v_2 - v_1)$ or the fluid on the bottom is $F = M\ (v_1 - v_2)$. If the fluid is deflected parallel to the hole bottom then $v_2 = 0$.

Letting $v_1 = v$ then

$$F = Mv = \rho' \frac{Qv}{g} = \rho' \frac{a C_1 v^2}{g} \quad . \quad . \quad . \quad (7)$$

Substituting (3) into (7) and neglecting C_2 since it is about 1.

$$F = 2aC_1 p. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (8)$$

$a = A = .009588\ in^2$
$C_1 = .8$

then $F = .0153P$ . . . . . (9)

$p = P =$ pressure, psi
$F =$ force

* * *

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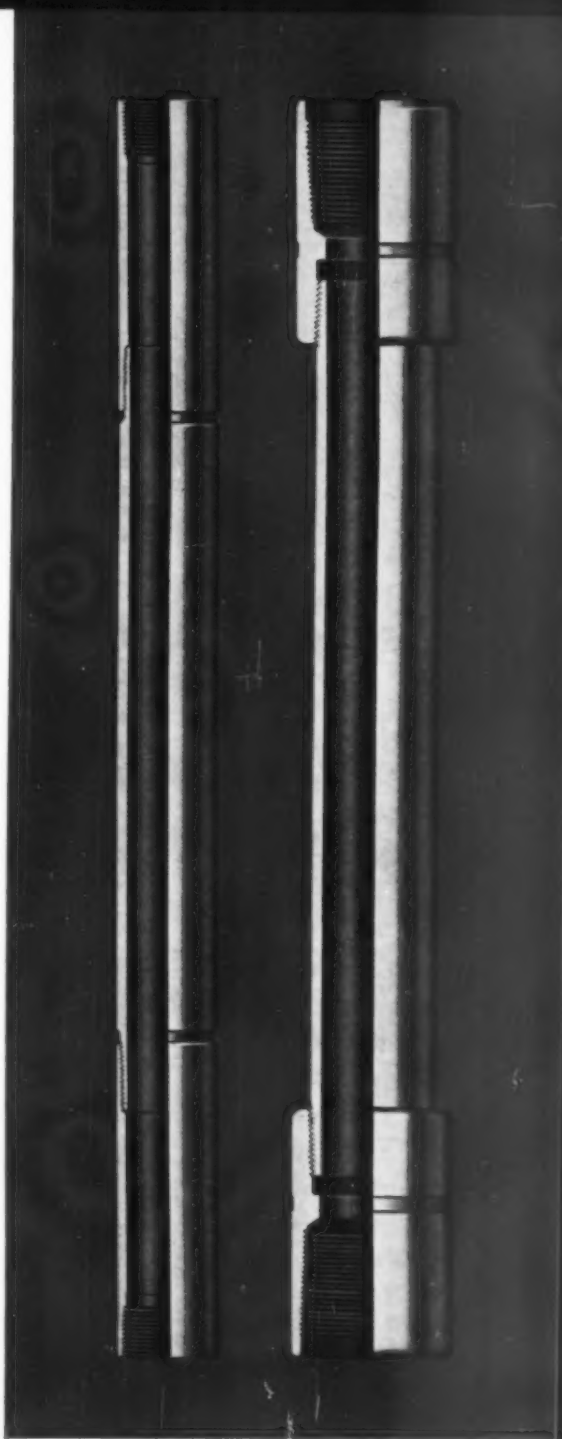

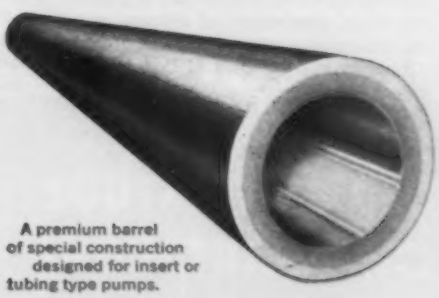

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*U.S. Patent No. 2,647,847

FIG. 1. **Packaged automatic production system** undergoing complete field testing under actual lease conditions at Oklahoma City.

From Wellhead to Pipeline . . .

Packaged Lease Automatic System Controls Production

Included in this fully automatic program are:

- **Wellhead shut-in control**
- **Well test control**
- **Well flow control**
- **Tank switching**
- **Custody transfer**
- **Fluid metering**
- **Lease safety controls**

FULL lease automation from wellhead to pipeline is now available in a packaged system that includes fully automatic wellhead shut-in control, well test control, well flow control, tank switching, custody transfer, fluid metering and lease safety controls. The packaged automation program offers greater accuracy, elimination of routine manual procedures on the lease site, greater efficiency in all phases of lease operation and substantial savings on operating expenses.

This new packaged lease automatic control system was developed by Black, Sivalls and Bryson, Inc. and extensively tested under field conditions at the company's research and development facilities at Oklahoma City.

Two Primary Classifications

The new lease automation component systems fall generally into two primary classifications: (1) Phantom pumper system which controls production from wellhead to the stock tanks; and (2) phantom gager system which provides fully automatic gaging and transfer into the pipeline.

Pumper components. This phase of the new system provides:

1. Automatic wellhead controls which program production to meet state regulations requiring wells to be shut in when the allowable production has been reached. Also, new safety shut-in devices operate at any time if an unsafe condition develops.

2. Automatic well testing equipment which automatically switches wells from production to testing and records data. On completion of test, the well is automatically placed back into production and another well put on test. Separator, treater and well testing unit are shut down automatically if high pressure or high or low liquid levels develop in the equipment or if treating equipment does not function properly.

3. Tank battery control equipment which automatically fills all tanks to capacity in a pre-set sequence and automatically bypasses tanks already full or being run to the pipeline.

The gager components. In this phase of the system, the following functions are provided:

1. Automatic measurement and recording of temperature compensated oil volume in barrels.

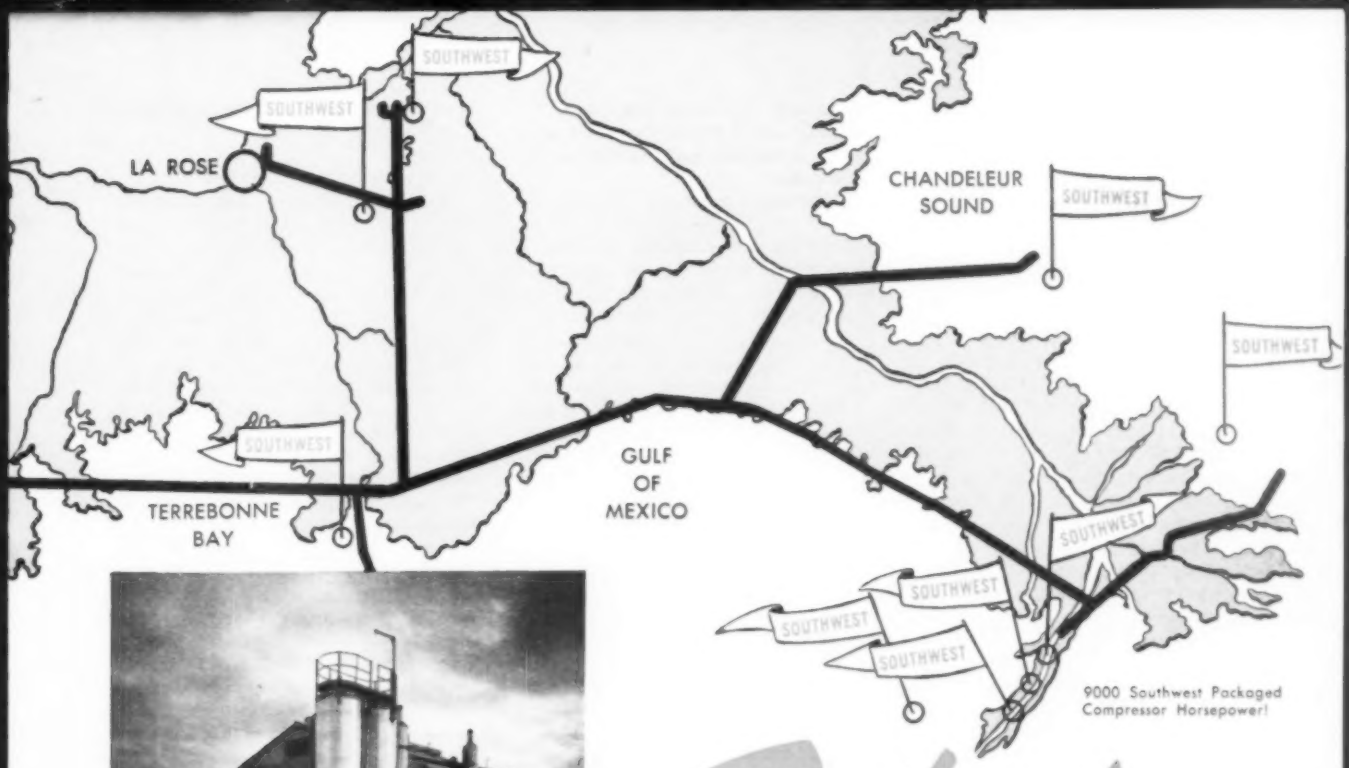
2. Automatic measurement of quality and contaminant.

3. Automatic running of crude from lease into connecting pipeline in accordance with predetermined schedules, on an unattended basis.

How Components Function

For the wellhead, controls now program production to meet state requirements. They automatically shut the well in when the allowable production has been reached. In addition there are safety shut-in devices which operate whenever an unsafe condition develops.

For well testing, a unit has been designed which automatically switches wells from the production system into a test system for a pre-set time of testing. On completion of the test, the well is placed back into the production system and another well is put on test. The production separator and treater as well as the well testing unit are complete with controls which shut down the lease if high pressure or high or



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low liquid levels develop in the equipment or if the treating equipment does not function properly.

Custody transfer. To complete the new system, a Lease Automatic Custody Transfer system (LACT) was designed to duplicate automatically efforts of the pumper and gager in running oil to the pipeline. It automatically fills and empties a meter tank of fixed volume, takes a continuous pipeline sample of the oil, records and controls the basic sediment and water content of the oil through a special monitor, which assures the pipeline of clean oil, and finally registers the gravity of the oil. This information is placed on a strip chart or printed card that serves as a record of the oil run on each dump of the meter. The complete system is controlled electrically with either electric or pneumatic valves.

Field tested. To test the components adequately, a full scale system was installed at the BS&B Oilfield Development Laboratory in Oklahoma City. The worst conditions anticipated in the field were selected for making trials and an extensive test program was undertaken. Under typical production conditions, crude oil was pumped at rates of up to 3500 bbl per day. Crude was mixed with water and gas at the wellhead, and it flowed through a completely automatic lease system set up for the test.

Component packages. Preparatory to setting up the test equipment, a complete study of the overall problem of crude production was undertaken from an engineering standpoint. From this study all possible trouble spots were reviewed and equipment was designed to overcome specific sources of difficulty. Many types of controls were checked to determine which would provide maximum operational characteristics.

On establishing equipment to be used, development engineers set out to package the unit neatly so that pieces could be interchanged with a minimum of effort and down time. The system was made "fail safe" so that in case of power failure or shut down, the system would halt operations immediately for safety reasons and would start again (after the trouble was remedied) at the same part of the sequence where it had ceased.

In addition to the low pressure oil circuit used to prove the merits of lease automation, a high pressure gas circuit, 1000 psi working pressure, capable of flowing 10,000,000 std cu ft of natural gas per day, is available at the development laboratory for testing high pressure gas equipment.

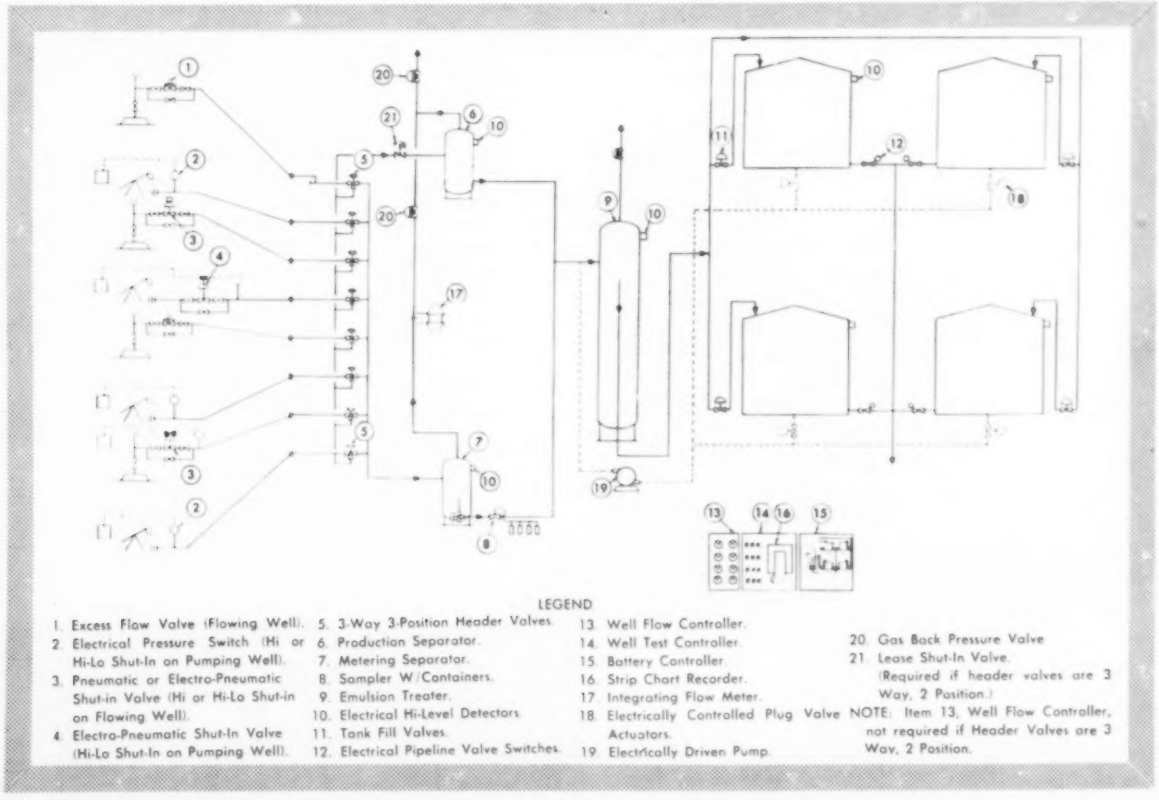
FIG. 2. **Typical producing lease** with pumping and flowing wells is shown in this simplified diagram which does not include the automatic custody transfer unit.

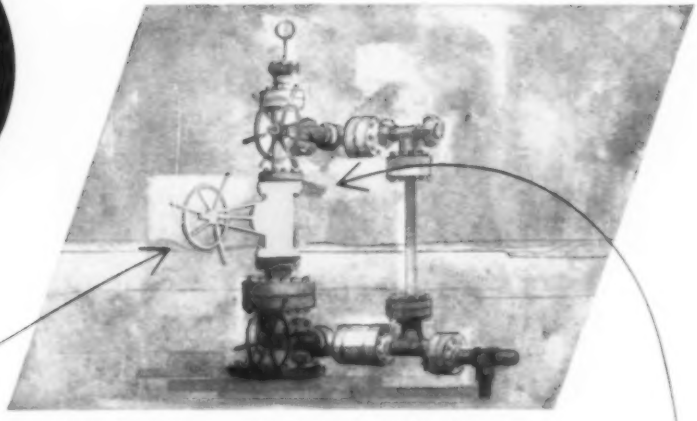
How the System Works

Automatic wellhead controls. Automatic controls are used according to well requirements, and whether the well is flowing or pumping. For flowing wells, two control units are employed; one for high pressure wells from which the high pressure flow exists up to the central header where flow is stop-cocked, and one for high pressure wells where flow line pressure is regulated at the wellhead. In the former case, an excess flow valve with a by-pass is used. For the latter type wells, a diaphragm type regulator and by-pass are installed at the wellhead.

For pumping wells, two electro-pneumatic systems are provided. An electrically-operated motor shut-in pressure switch assembly is used when the electric motor driven pumping unit is operating and when the well can be stop-cocked at a central header. Second system employs an electro-pneumatic motor shut-in pressure switch and control valve assembly. This is used on electrically powered pumping units at the wellheads when not pumping and where the flow can be stop-cocked at a central header.

Electro-pneumatic flow control. Well


LEGEND
1. Excess Flow Valve (Flowing Well).
2. Electrical Pressure Switch (Hi or Hi-Lo Shut-In on Pumping Well).
3. Pneumatic or Electro-Pneumatic Shut-in Valve (Hi or Hi-Lo Shut-in on Flowing Well).
4. Electro-Pneumatic Shut-In Valve (Hi-Lo Shut-In on Pumping Well).
5. 3-Way 3-Position Header Valves.
6. Production Separator.
7. Metering Separator.
8. Sampler W/Containers.
9. Emulsion Treater.
10. Electrical Hi-Level Detectors.
11. Tank Fill Valves.
12. Electrical Pipeline Valve Switches.
13. Well Flow Controller.
14. Well Test Controller.
15. Battery Controller.
16. Strip Chart Recorder.
17. Integrating Flow Meter.
18. Electrically Controlled Plug Valve Actuators.
19. Electrically Driven Pump.
20. Gas Back Pressure Valve
21. Lease Shut-In Valve. (Required if header valves are 3 Way, 2 Position.)
NOTE: Item 13, Well Flow Controller, not required if Header Valves are 3 Way, 2 Position.



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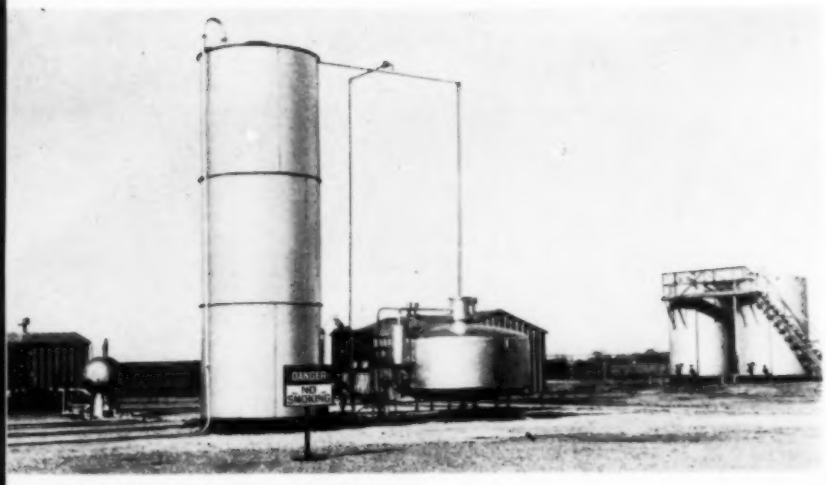


FIG. 3. **Lease automatic custody transfer** of oil into the pipeline is accomplished by this system which measures oil and quantity and quality and automatically transfers it to the pipeline.

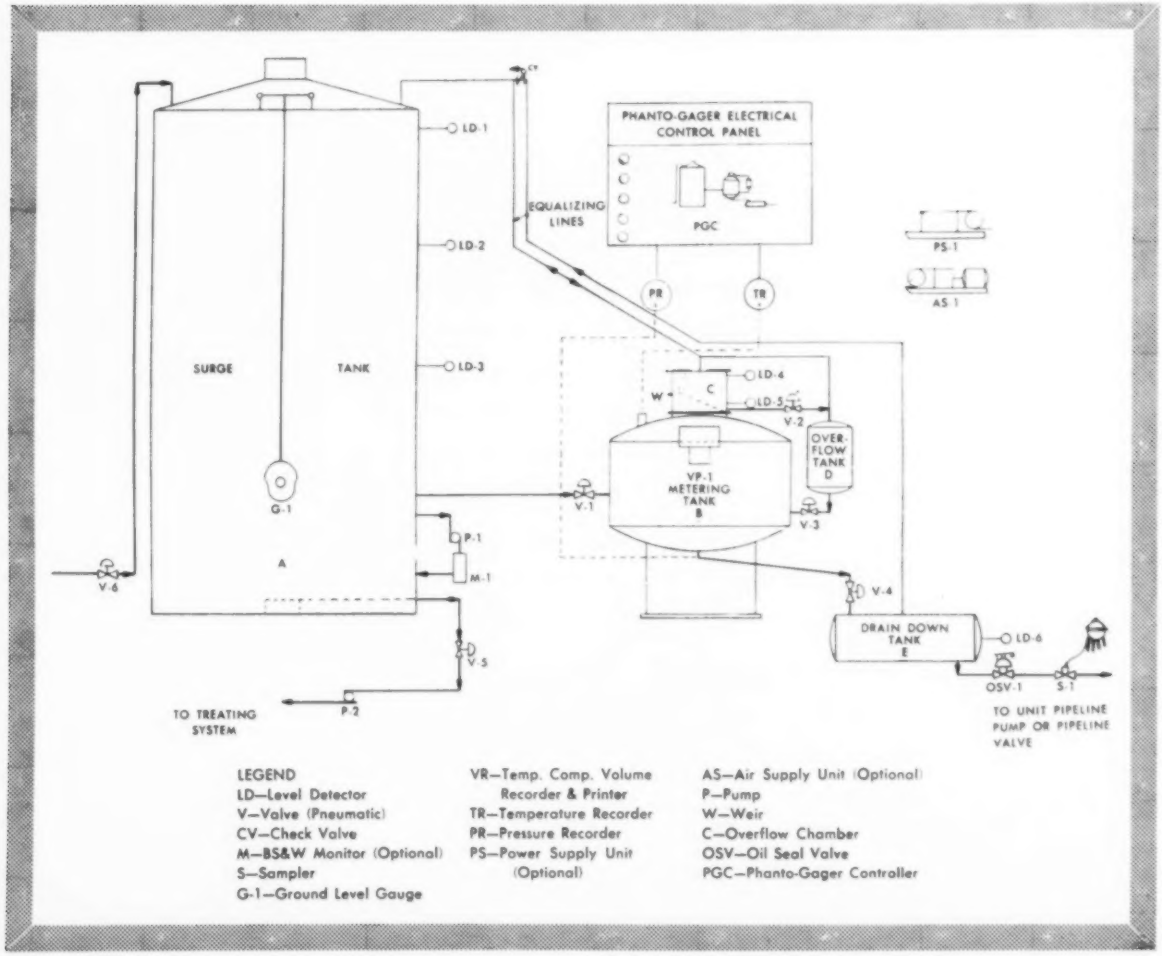
flow control involves automatic programming at a central header. This is done by positioning 3-way, 3-position header valves to route the flow from a well to production, to test or stop-cock the flow at the header.

If high pressure flow lines are in place, then wellhead pressure can be carried on the system up to the chokes located at the automatic header. If low pressure flow lines are in place, then pneumatic or electric pilot controlled shut-in valves would be installed at the wellhead to keep this well shut-in pressure off the flow lines.

It is desirable to incorporate the well flow control with the well test control since the former facilitates programming the flow from wells, while the well test control involves programming the flow through the test equipment, including control of the functions involved.

Well test control. Automatic control of well test programming and recording of necessary data are performed by electro-pneumatic means. Electrically controlled 3-way, 2-position header

FIG. 4. **Automatic metering** of produced oil into the pipeline starts at the surge tank at left in this schematic flow diagram.



valves are used to divert the flow of oil from individual wells through either the production or the well test equipment. The latter includes a test metering separator or treater, equipped to meter oil, gas and water. When a metering separator is used, water percentage is usually obtained by automatically extracting an average sample. The test operation is controlled by an electrical well test controller and includes an operational strip chart for recording all well test data.

Tank switching. Electro-pneumatic switcher controller is used for switching from 2 to 20 tanks and enables the lease operator to obtain complete automatic tank battery operation. All tanks are filled to capacity using all storage available for maximum runs to the pipeline without the necessity of manual switching. One tank fill valve opens at a time, filling tanks in a pre-set sequence. When a tank becomes full and actuates the high level detector, its fill valve closes and the fill valve on the next available tank in sequence is opened. Tanks already full or being run to the pipeline are automatically bypassed. The plug valve on the pipeline outlet from each tank is equipped with a lock-out switch eliminating the possibility of filling into a tank while it is being run to the pipeline.

Automatic custody transfer. To transfer crude from the lease battery into the pipeline with minimum storage facilities, and replacing numerous manually-performed operations is the automatic gager system which measures oil quantity and quality and automatically transfers oil to the pipeline.

Either a 25 or 50-bbl unit is used, equipped with one surge and one meter tank. If needed for larger volumes of flow, systems employing multiple units can be used. Standard control system is electro-pneumatic employing diaphragm operated motor valves with electric solenoid pilot valves. Control circuit is 110-v and 20 psi pneumatic pressure to operate the valves. All level detection instruments, control panels, instruments and motors are electric.

How it works. Transfer of crude oil from the lease to the pipeline through the automatic gager system starts when valve V-6 of Fig. 4 is open and surge tank A is filling. All other valves in the system are closed. Level detector LD-3 is actuated and the oil level continues to rise until level detector LD-2 is actuated. Valve V-1 then opens and oil equalizes into metering tank B. Oil level rises in metering tank B until it overflows weir W and fills overflow chamber C, actuating level detector LD-4 which closes valve V-1.

The oil in metering tank is allowed to settle for a set period of time (adjustable 0-24 min) to allow escape of any entrained gas bubbles. At the end of the settling period, valve V-2 opens and the oil is drained from overflow chamber C into overflow tank D until the level is drawn down behind weir W, actuating level detector LD-5. A time delay is actuated holding valve V-2 open for an additional set period of time (adjustable 0-10 min) for stabilization of a positive high level gage over weir W.

After oil has stabilized at weir W level and immediately prior to opening valve V-4, the average oil temperature in metering tank B is recorded and the temperature compensating volume recorder VR-1, records temperature compensated oil volume in barrels cumulative for printing on gage card. Valve V-2 then closes and valve V-4 opens allowing oil to equalize into drain down tank E, actuating level detector LD-6. This energizes a time delay (adjustable). This delay provides the time necessary for oil to fill to drain down tank E displacing vapors through equalizing line and check valve CV. The pipeline pump or pipeline valve is then energized discharging the calibrated volume of oil metered between the seats in valves V-1, V-3, V-4 and weir W.

When the oil level in drain down tank E drops across level detector LD-6, the pipeline pump or pipeline valve is shut off and a time delay (adjustable) is energized. This time delay allows any metered oil remaining in metering tank B to drain into drain down tank E, establishing a positive low level gage. Drain down valve V-4 closes and valve V-3 opens for a time period (adjustable) to drain the oil from overflow tank D into metering tank B. Valve V-3 then closes and valve V-1 opens to repeat the filling process of metering tank B. The above described cycle can be applied to more than one metering tank where continuous flow to pipeline is desired.

Pump P-1 continually extracts a sample from the lower section of surge tank A and pumps this sample through monitor M-1 and back into the surge tank. Should the BS&W content exceed pipeline requirements, valve V-1 is automatically closed. Valve V-5 is opened and recirculating pump P-2 is started to recirculate the bottoms of surge tank A back through the treating system. When the BS&W monitor again detects pipeline quality oil, valve V-1 is permitted to open. Recirculation through valve V-5 and pump P-2 is continuous until the BS&W content of the oil reaches a predetermined percentage (adjustable). In addition, bottoms from surge tank A are periodically (frequency and recycle time adjustable) automatically through valve V-5 and pump P-2 to maintain low BS&W content. ★ ★ ★

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Tips on Mud Valves for Toolpushers . .

Zack Taylor (right) and Toolpusher Jim Wilkson discuss the MUDWONDER on the standpipe of the Falcon-Seaboard Rig No. 9.

Mud Valve Economy, Easy Operation Found In Rockwell-Built MUDWONDER

by Zack Taylor, Division Manager
Falcon-Seaboard Drilling Company, Denver, Colorado

ECONOMY . . . Easy operation . . . Have you searched in vain for mud valves that would give you these benefits? We did until our experience with Rockwell-Built *Mudwonders*. Now, we use them on standpipes, mudlines, mud tanks, blowout preventers, etc. Eight months of testing and using *Mudwonders* proved to us that they are superior to any mud valve we have ever used, regardless of application.

Economy means more to us than just long wearing parts which are inexpensive to replace. It means freedom from downtime and costly maintenance, too. *Mudwonder* valves give us "our type" of economy. We can inspect the inside of a *Mudwonder*, change the seat insert if necessary, and be ready for operation again while the crew makes a connection.

We never need a cheater or hammer on a *Mudwonder* valve. Easy operation is no longer a roughneck's dream. It's real . . . and at extreme differential pressures, too.

We can recommend *Mudwonder* to any toolpusher having mud valve trouble. *Mudwonder* valves are built in 2″, 3″, and 4″ sizes with screwed or flanged ends for 2000 psi WP (4000 psi test) and 3000 psi WP (6000 psi test).

See your favorite oil field supply store for complete information, or write Edward Valves, Inc., East Chicago, Indiana.

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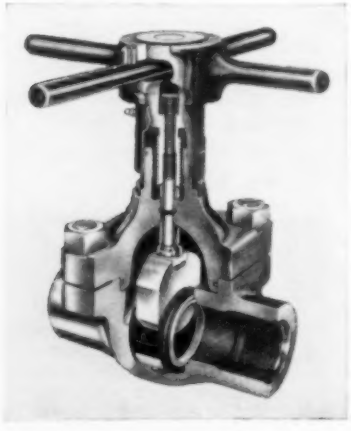
MUDWONDER cut-away view shows the double thread construction, separated stainless stem and hard chromed gate with "T" slot connection and the one-piece seat insert with the buna-N molded integrally over the steel wear rings.



Mid-Continent API Names E. E. Young As President

E. E. Young, new district chairman and F. F. Wright, retiring chairman.

E. E. Young, Sohio Petroleum Company, Oklahoma City, was elected district chairman of the Mid-Continent district of the Division of Production, American Petroleum Institute, during the final day of the three-day meeting held in April in Tulsa, Oklahoma.

The new district chairman succeeds F. F. Wright, Sinclair Oil and Gas Company, Tulsa, and will serve one year.

The other new officers are: J. T. Nutter, Midstates Oil Corporation, Seminole, vice chairman for the Seminole-Oklahoma City area; James W. Rockhold, petroleum consultant, Great Bend, Kansas, vice chairman for Kansas; Charles P. O'Loughlin, O'Loughlin Well Service Company, Perry, vice chairman for the Drumright-Perry area; Fred J. Neslage, West Pampa Repressuring Association, Pampa, Texas, vice chairman for the Texas Panhandle; J. A. Maurer, Mack Oil Company, Duncan, vice chairman for the southwestern Oklahoma area; and Gene Bates, The Texas Company, Maysville, vice chairman for the Golden Trend area.

John Terry, Lane-Wells Company, Oklahoma City, was elected secretary-treasurer, and F. F. Wright, Sinclair Oil and Gas Company, chairman of the district advisory committee.

During the district's dinner meeting D. L. Connelly, Warren Petroleum Corporation, Houston, and vice president of API for production, presented "Citations for Service" to: D. L. Trax, Topeka, Kansas; Neslage; J. H. Field, Sohio Petroleum Company, Oklahoma City; Ross Bolton, Crescent Corporation, Tulsa and L. E. Fitzjarrald, Phillips Petroleum Company, Bartlesville.

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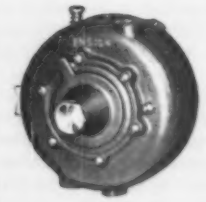

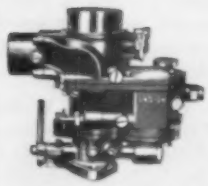

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After machining, Ensign bronze castings "HOLD THEIR SHAPE" against distortion of mounting screws etc. thereby eliminating gasket and water leaks. There is no question about it—it costs more to produce an Ensign Vaporizer, Carburetor or Filter of bronze alloy, yet the selling price is frequently less because we produce thousands at a time for distribution all over the world.

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EXPLORATION ACTIVITIES

BARBADOS

★ Gulf Oil Corporation has disclosed that it has suspended drilling operations on this West Indies island. Company indicated that drilling was stopped because of mechanical difficulties caused by a high pressure gas area. A company official said that the stoppage was not permanent and exploration may be resumed. No date for the resumption has been set, however. Gulf has conducted exploratory work on the island for seven years, finding only gas and condensate.

TEXAS

★ A wet gas discovery has been recorded in the upper Texas Gulf Coastal area by Pan American Petroleum Corporation. The find is the No. 1 Grayburg Timber Company in south Liberty County over a mile southeast of the Hull dome area. Well gaged 3,160,000 ft of gas daily through a ¼-in. choke plus an ungaged amount of condensate. Flow was from perforations at 8055-64 ft.

★ A sixth pay level in the Tompkins multipay field of Stonewall County, West-Central Texas, has been established by Sun Oil Company. Sixth consecutive zone was found at the No. 4-A Martin. On a test of the Caddo lime from perforations at 5473-76 ft and 5481-90 ft, it swabbed 47 bbl of oil and 55 bbl of water on a 12 hour test. Operators plan a dual testing of the Ellenburger lime from 5833-69 ft and 5908-32 ft; if successful, it will be the third producer from that zone in the multipay pool. Other zones that have indicated commercial production are the Canyon sand, Strawn sand, Mississippi chert and Cambrian sand.

★ Largest producing well for the Anadarko Basin of northwestern Texas has been established at the Shamrock Oil and Gas Corporation No. 1-B Steele, in 50-45 H&TC Survey. Wildcat flowed for three hours to receive a calculated 24-hour potential of 2176 bbl per day. Discovery is 10 miles north of Spearman, in Hansford County. Oil came from the Atoka sand that was tested through perforations at 6667-83 ft. The producer lies between two dry holes.

DENMARK

★ Drilling for oil in Denmark will start again soon on a larger scale than before, the Copenhagen office of Standard Oil Company (New Jersey) has announced. The announcement followed negotiations with the Danish government for the rights, formerly held by Gulf Oil Corporation.

VENEZUELA

★ Venezuelan Petroleum Company has announced successful completion of an additional exploratory well on its 92,600 acres Aguasay Block in the State of Monagas in Eastern Venezuela. New well, considered a significant discovery and adding materially to the prospects of the area, is the Aguasay No. 4. It is located five miles west of the No. 3 discovery well completed last October. It was completed from two producing sands at depths of 13,200 and 13,400 ft for a combined initial production of 1613 bbl a day of 37 deg gravity oil. An aggressive drilling program is already underway, company officials report.

Offshore drilling barge, towed to the site from Texas, is located a half mile off Pointe-a-Pierre, which is 12 miles from Brighton, Trinidad. It is being operated by a subsidiary of McColl-Frontenac Oil Company Limited of Canada, a subsidiary of The Texas Company.
— Courtesy Texaco

SAUDI ARABIA

★ Discovery of oil in an exploratory well, drilled 12 miles north-northwest of the northernmost well in the 140-mile-long Ghawar field in Saudi Arabia, has been announced by the Arabian American Oil Company. This well was drilled to a total depth of 7325 ft. It has been completed at a depth of 7120 ft for potential production from the D member of the Arab zone. This is the same member that is productive in Aramco's Ghawar, Abqaiq and Dammam fields, and which was recently proved productive in the Khursaniyah field. The new well, known as 'Ain Dar Well No. 56, is located approximately 55 miles southwest of Dhahran, Aramco's headquarters. Further geophysical work is under way and additional drilling is planned to assist in evaluating the area.

LOUISIANA

★ Union Oil Company of California announced completion of well to extend the productive field limits. Cotten Brothers 1, a dual completion, came in as a significant extension to the East Lake Palourde field, Assumption Parish, with initial flowing production of 536 bbl per day through a restricted choke. Gravity of the upper zone was 30 deg, and of the lower zone, 37.8 deg. Six separate sands were penetrated before the well was completed below 12,800 ft. The company has in excess of 5000 acres around the well.

★ In Vermilion Parish, the Union of California completed Louisiana Furs D-2, a gas distillate well, which extended the productive limits of the Live Oak field by nearly a mile to the west. The well, drilled to a depth of 13,425 ft, came in for initial production of 2,290,000 cu ft of gas and 145 bbl per day of 35 deg crude.

★ In Calcasieu Parish, W. E. Walker has recorded a new oil pay two miles northeast of the Perkins field. Discovery well is the No. 1 Walker-Corbello, 26-11s-7w. It flowed 100 bbl of condensate per day with 3,000,000 cu ft of gas per day through 9/64-in. choke from 11,274-83 ft.

★ New pay zone for the Palmetto Bayou field of Terrebonne Parish has been found in Humble Oil & Refining Company's No. 3-W LL&E Company well, 1-19s-12e. New pay is at 12,620-23 ft, yielding 504 bbl of oil per day through 8/64-in. choke.

Ask the operators who have seen it! Field Laboratory No. 56 is the finest combination package of well logging and core analysis equipment ever put into commercial service — *to pinpoint stray pays, pick proper coring points at major objectives, and to plan completions with accurately measured data.*

First to be finished in a fleet of new skid-type, portable laboratories, FL-56 represents a concentrated effort by Core Lab's Research and Development Department. Coordinating eighteen months of detailed testing and design with the experience of on-location personnel, these units carry virtually every known aid proven to be "field practical" in the continuous analysis of mud and cuttings during drilling operations.

Among its many scientific refinements and innovations, FL-56 features a new super-sensitive gas trap, modified gas detector circuits for greater stability and range, pump stroke counters, pump rate meter, a mud pit level instrument, and total depth and "off-bottom" counters. In addition to other standard well logging devices, four strip chart recorders are used to provide continuous records of gas in the mud, drilling rate as a bar graph, direct measurement of weight on the bit, and pump pressure.

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Exploration

ARKANSAS

★ A wildcat well is planned in the extreme northeastern part of the state by the Grant Gallatin Drilling Company. Permit has been given the company for No. 1 Caloway, SW SW SW 17-19n-8e, in Clay County, not far from the Arkansas-Missouri line. The Missouri Geological Survey has reported considerable leasing in counties along the border.

KANSAS

★ A Lansing-Kansas City and Reagan sandstone test for Norton County has been staked by Cities Service Oil Company. The 3800-ft test is Young C No. 1, located on the Cities Service 3750-acre Norcatur block, approximately 10 miles west of Norton. The test is spotted center SW SW NE, Sec. 35-2s-25w, 8.5 miles northwest of nearest production.

GEORGIA

★ Another try for Georgian oil production is slated by the Renwar Oil Company. Well is the No. 1 Dallas, C SE NW LL 111-LD 15 in Decatur County. Wildcat is in the Bainbridge area in the most southeasterly county of the state. It is north of Gadsden County, central Florida.

PENNSYLVANIA

★ One of the most productive natural gas wells in the Rockton Luthersburg field in western Pennsylvania was recently completed by Keta Gas & Oil Company. The new well, located near Luthersburg, Brady township, Clearfield County, was tested at 4,886,000 cu ft per day. Average test yield for wells in this area had been approximately 2,750,000 cu ft per day. Keta's rig began drilling the site — Nolder No. 1—on February 12 of this year, drilled the greater part of the well and performed the entire completing operation by March 10. A minor portion on the well had been drilled before Keta moved its rotary rig on the location. Keta is one of the most active drillers in the western Pennsylvania natural gas fields with 16 sites currently being explored or drilled. On 13 of these sites drill rigs are in operation.

★ Peoples Natural Gas Company No. 4109 B. H. Smithley, a wildcat in Mount Pleasant township of Westmoreland County in the southwestern portion of the state, has opened a new gas pool from the chert at 7364-7539 ft. On a 24 test, the well gaged 2,564,000 cu ft.

KENTUCKY

★ J. O. Mutch and R. Steinhorst No. 1 Edward Bryant, a wildcat in Cumberland County, has found the Pencil Cave sand productive. The wildcat is six miles west of the Burkesville, West Kentucky field. On a production test, the well flowed 50 bbl per day from shallow sand zone at 531-601 ft. Kentucky nomenclature committee has yet to name the new area.

ALABAMA

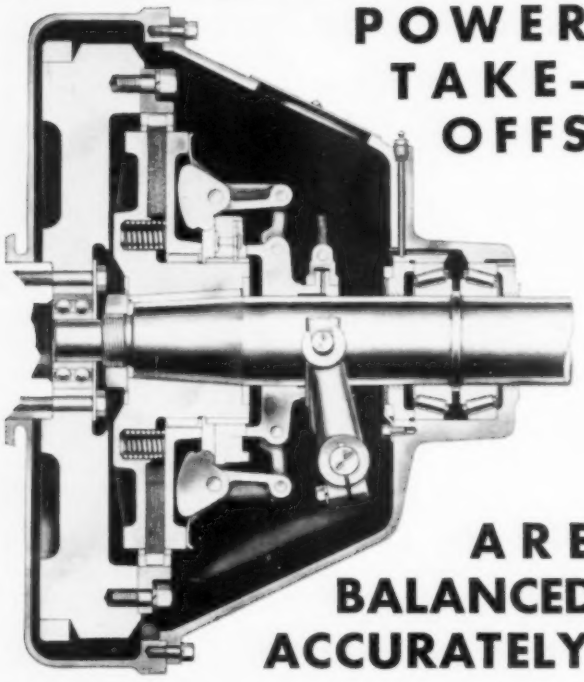
★ A new dry gas pool for Marion County, in the northwestern portion of the state, has been opened by Wallace Pearson and associates at the No. 2 First National Bank of Birmingham, 5½ miles north of the town of Boston. Although the test was slated for 3500 ft, well was completed in three zones of the Lewis, or Bethel, sand at 1530-53 ft, 1554-60 ft and 1569-73 ft. Zones gaged 2,240,000 cu ft of gas a day. In the early part of April, it was reported that some 23 wildcats were drilling in the state, while 18 were going in the Citronelle area of Mobile County.

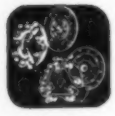
ILLINOIS

★ Williamson County's first flowing well is a new discovery in the Marion area. Successful wildcat was Ward M. Dayton's No. 1 in the Tri-State field in the southern Illinois area. Operator tested two zones of the McCloskey lime at 3025-113 ft to make gas in three minutes and flow oil in 16 minutes. Both flows were not computed. Log indicated that the McCloskey was topped at 3034 ft.

ROCKFORD

POWER TAKE-OFFS

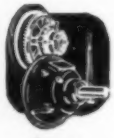


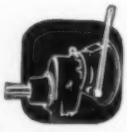

Small Spring Loaded

Heavy Duty Spring Loaded

Oil or Dry Multiple Disc

Heavy Duty Over Center


Power Take-Offs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CLUTCHES

ARIZONA

★ Leasing activity is reported high in the Four Corners area of this state on both state and federal lands. Most active is the so-called "Strip" country north of the Grand Canyon and at the southern end of the Kaiparowits Basin. First wildcat to get started in Arizona this year is the Kerr-McGee Oil Industries No. 1 State, about 42 miles northeast of Holbrook in the Black Mesa Basin area of Apache County. Company already has two other tentative locations staked in the region. Another operator, Pan American Petroleum Corporation, is reported to have concentrated a lease block in the Dry Lake area of Navajo County.

CANADA

★ Thomas Jordan, Inc., of New Orleans has taken licenses to explore for oil and gas on approximately 250,000 acres in the Cumberland Basin area of Nova Scotia, Canada. The area has been explored very little by the drill but contains numerous prospective structures and oil and gas seeps. Commercial production has been established in one shallow oil and gas field near Moncton, New Brunswick. Other leaseholders in the area include Imperial (Standard Oil of New Jersey) and Eastern Northern Exploration Company. Rodgers and Seglund Associates of New Orleans have been retained as exploration and development consultants.

★ Gridoil Freehold Leases, Ltd., announced that it is just completing a third well on its wholly owned 800-acre tract west of the presently defined limits of the Weyburn field. These wells are part of Gridoil's 1956 exploration program in which the company drilled 17 wells with negative results in only five locations. All of the drilling was in southeastern Saskatchewan. The third well, Gridoil Weyburn No. 16-27, is just being completed at 4661 ft, will prove either an extension to the west of the Weyburn field or may prove up an entirely new field. First well, Gridoil Weyburn No. 12-26, has an allowable of 314 bbl per day with a pay sand calculated at 90 ft by the Conservation Board. The second well has an allowable of 164 bbl per day. Gridoil's engineers estimate an additional seven locations on 80-acre spacing for the 800 acres.

★ Exploration activity has been stepped up on both sides of the St. Lawrence River in Quebec as a result of a natural gas discovery 12 miles east of Three Rivers. Find was made by Bald Mountain Oil Company. Its well has been tested, making a daily flow of 3,600,000 cu ft. The discovery is in the St. Lawrence Valley between Montreal and Quebec City, and marks the first large strike made in the area.

NEW MEXICO

★ Lion Oil Company, a division of Monsanto Chemical Company, has announced the completion of the Atlas No. 1 as an oil discovery well in San Juan County. This is the company's first oil production in the San Juan Basin. The well, completed on pump, produced 110 bbl of 41.1 deg gravity oil on a 24-hr test. Production is from the Lower Gallup sand through perforations from 5362 to 5412 ft. Located about 30 miles southeast of Farmington and 13 miles southeast of the Bisti field, the well was drilled in section 34, township 25N, range 10W. The company has leases on 480 acres in the immediate vicinity.

★ Sinclair and Reiter-Foster Oil Corporations are undertaking in a joint effort, the drilling of a well north of Hobbs, Lea County, according to an announcement by Reiter-Foster officials. The drilling site adjoins a recent discovery well. In addition, Reiter-Foster plans to join in a unit wildcat project (deep Devonian test well) in northwestern Lea County, with the Skelly Oil Corporation.

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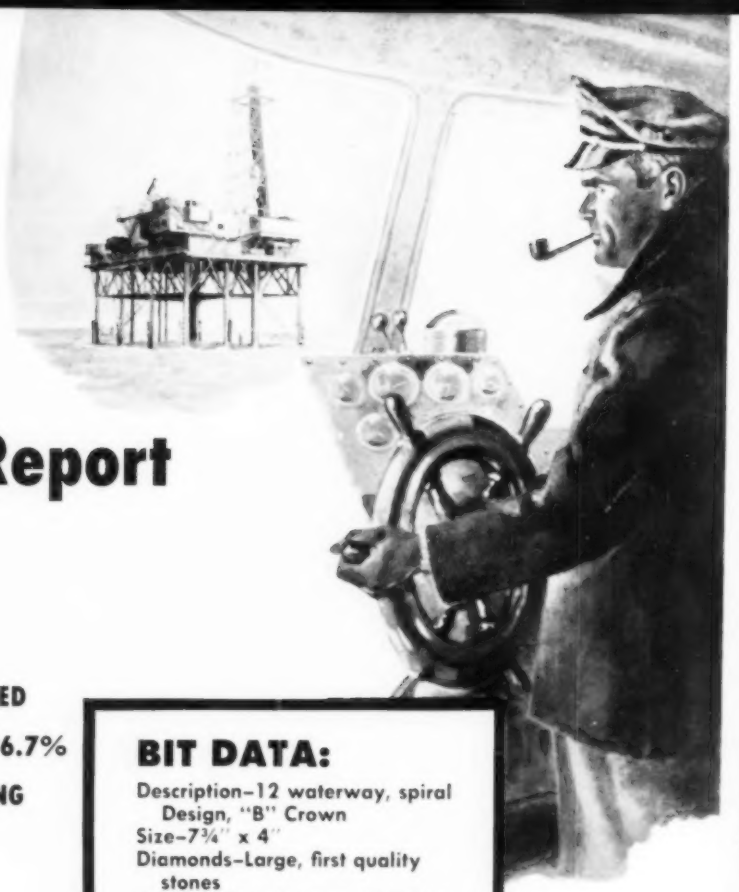

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DIAMOND CORING BIT INCREASED PENETRATION RATE BY 100%, REDUCED BIT COST PER FOOT BY 75%, GAVE 96.7% CORE RECOVERY IN STICKY, CRUMBLING SAND AND SHALE.

BIT DATA:

Description–12 waterway, spiral Design, "B" Crown
Size–7¾" x 4"
Diamonds–Large, first quality stones
Original Bit Sale Price–$4860.00
Net Bit Cost–After Salvage, $1500.12
Bit Cost per Foot–$3.24

Location:
Offshore from Morgan City, Louisiana

Formation:
Unconsolidated green shale and sands of Upper Miocene Age.

Performance:
This Christensen Diamond Coring Bit cored a total of 463 feet at 4 feet per hour and the operator recovered 448 feet of core. Other types of coring equipment were coring at 2 feet per hour, bit life averaged 12 feet, core recovery was approximately 40% and round trips were taking 7 hours each. The peculiar sticky, crumbling sand and shale, although only medium hard, presented a difficult coring problem. The formation would clog the bit, yet excessive fluid volume would wash the core. The spiral waterway design coring bit, with each waterway angled so fluid would flow across bit face, assured uniform cleaning and cooling of the diamonds. The Christensen Engineer also recommended a shim adapted to the core barrel to bring the inner tube shoe closer to the mouth of the bit, reducing to a minimum the area of core exposed to drilling fluid.

Operating Conditions:
Bit load — 6000-10,000 lbs. Rotary table speed — 40-50 RPM
Fluid volume — 170 GPM. Water depth — 60 ft. Remarks — Directional hole with 3 whipstocks set, no unusual drag encountered.

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WYOMING

★ First well drilled below the Cretaceous in the Donkey Creek field on the north side of the Powder River Basin in Crook County has found oil in the Pennsylvanian. Discovery well is True Oil Company's Burrows B-6. It flowed at the rate of 28 bbl per hr through ¾-in. choke from perforations at 7727-47 ft. Operator had previously swabbed 898 bbl of oil in 18½ hours from the same interval. Swab test at 7794-7804 ft also recovered oil. Gravity of the oil is 31.5 deg. While the Pennsylvanian is a principal producing horizon on the southern side of the basin, there has been no pre-Cretaceous discovery on the north side with the exceptions of two minor fields, Adon and Mitchell. The Donkey Creek discovery is likely to stimulate deeper drilling in the area.

UTAH

★ Shell Oil Company has extended the North Desert Creek field one mile to the southeast, in San Juan County, at the company's No. 42-13 North Desert Creek Unit. Field now extends nearly three miles in a northwest-southeast trend. There are four producers and no dry holes. New well was acid-washed before testing perforated zone at 5452-5534 ft. Well then flowed at the rate of 1500 bbl per day on initial test. Company has already begun its No. 14-12 Unit in SW SW of 12-41s-23e, one half, mile southwest of nearest production.

NEBRASKA

★ Great Basins Petroleum Company has made location for No. 1 Warner, SE SW SE 36-1n-27w Red Willow County, Nebraska. The well is to be a granite test to a depth of about 3625 ft. The test, to be drilled on a farmout from Cities Service Oil Company, is approximately one-half mile north of Lansing-Kansas City production in the Warner field, Decatur County, Kansas. This is the first of a three-well drilling program by Great Basins in the area. The additional two wells will be drilled in Decatur County, Kansas.

★ Western Nebraska sector of the Denver-Julesburg Basin has two new "J" sand discoveries. Raymond Oil Company No. 1 Johnson, C SW SW 1-17n-54w, in Banner County, tested the "J" at 5795 ft to flow 125 bbl of oil per day. Lowell J. Williamson's No. 1 Lane, C NW NW 30-15n-56w, in Williamson County, tested the "J" at 6740 ft. Final completion of these wells is supposed delayed by the late April blizzards that have swept the area.

MONTANA

★ Flank Oil Company, Billings, Montana, has indicated an apparent wildcat discovery of an entirely new producing horizon on the Sweetgrass Arch located in Glacier County in Northwestern Montana. This wildcat was drilled by Flank, the operator, in conjunction with United States Smelting Mining & Refining Company. The Bugbee No. 1 was drilled in the NWSESW of Section 6, Township 33 North, Range 6 West. Discovery was made in an 11 ft fractured limestone zone of the Basal Lodge Pole in the lower Mississippian. Cores showed fracturing from 4629-4640 ft with good oil staining throughout the interval. Drillstem test of this interval was run from 4625-4643 ft recently. When tester was opened gas flowed to the surface in two minutes measured at 1,300,000 cu ft daily. Drilling mud hit the surface in 15 minutes followed by oil cut mud in 17 minutes, and in 23 minutes the well was flowing clean green 36 deg oil. The well was allowed to flow for one hour and made 25 bbl. Production casing was set at 4625 ft and a service rig to complete the production tests is on location. This indicated discovery could have a tremendous impact upon the whole Sweetgrass Arch. There has been a minimum of drilling below the top of the Madison lime in this area with very few wells taking a look at the lower horizons. This pay in the lower Mississippian constitutes an entirely new oil reservoir for this area.

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check these actual results of a Double-E Tension Tubing Anchor

BEFORE	AFTER
36 bbl oil per day	55 bbl oil per day
558 bbl water per day	630 bbl water per day
74% pump efficiency	85.5% pump efficiency
4 rod jobs per month	No rod jobs

1957 Test

Interestingly, this tension tubing anchor was run strictly to prevent rod jobs. Yet look what happened to pumping efficiency!

The Double-E Tension Tubing Anchor

Efficiency in a pumping well increases vastly when tubing is anchored in tension. Just look:

1. You get more fluid lifted per stroke
2. Working life of tubing and rods increased
3. Rod jobs greatly reduced
4. Collar leaks and wear eliminated

Double-E Tension Tubing Anchor installs easily. Then, with its powerful grip on casing, it holds tubing motionless. This increases efficiency and working life of the entire tubing string!

Retrieving the tubing string and the anchor is quick and easy – without loss of parts in the hole. Write for full details today – or see Composite Catalog.

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What's doing in DRILLING

★ **Drilling and Exploration Company, Inc.,** is moving its headquarters from Houston to Dallas, Texas, on or about July 1. Shift is a part of a consolidation of executive and administrative offices for drilling and production into a combined headquarters. About 25 executives, engineering and supervisory personnel will be affected. Most of the group will come from Houston, although a small group is to be moved from Los Angeles headquarters office of Drillexco's contract drilling subsidiary, Drilling and Exploration Company of Delaware, Inc. This company will also be headquartered in Dallas. Office location has been staked in Dallas' yet-to-be-completed Exchange Bank and Trust Company building.

★ **Sohio Petroleum's Rig 5,** operating in the Eola field, Oklahoma, has completed another year with no lost time accidents. The record now extends to 1574 days. Our tin hat is off to the crews of Rig 5!

★ **Humble Oil & Refining Company** drilled 905 wells in 1956 at an average cost of $131,600, stockholders have been told. This compares with 857 wells drilled by Humble in 1955 at an average cost of $130,500. The company spent $127,520,700 for drilling last year, pouring more than $48,000,000 of the total into dry holes. Some 41 offshore wells cost an average of $580,400 per well.

★ **School of Drilling Technology** has graduated its largest class in Odessa, Texas. Among the group of 39 receiving the traditional hard hats and diplomas were 12 foreign students, 18 from Texas, and 19 from other parts of the U. S. H. W. Davidson of Midland, Texas, chairman of Education and Training of the American Association of Oilwell Drilling Contractors, one of the co-sponsors of the school, and Ed Durrett, Odessa, presided at the graduation. AAODC, Odessa College and extension division of the University of Texas sponsor the school. This is the seventh session of the school. Since its inception in the fall of 1954, some 235 men have been given instruction in drilling techniques.

★ **D and D Drilling and Construction Company, S. A.,** has been acquired by Falcon Seaboard Drilling Company. As a result, Falcon Seaboard has offered 300,000 shares of common stock to prepay outstanding indebtedness amounting to $1,213,757 incurred in the D and D acquisition. D and D has been engaged in drilling and oil well workover service in eastern Venezuela since 1951; Falcon Seaboard, operating 27 rotary rigs, is considered as one of the "big ten" U. S. drilling contractors.

★ **Unusual success** in exploratory drilling — a ratio of almost 50 percent — was achieved by Sun Oil Company during 1956, according to the company's annual report. As operator, Sun last year drilled 190 exploratory wells resulting in 55 oil producers, 39 gas/condensate producers and 96 dry holes. The company drilled more wells in 1956 than in any other year in its history. The report notes that the company's net interest in total wells drilled in 1956 amounted to 543 wells, including 340 oil producers, 55 gas/condensate producers, and 148 dry holes. Exploratory drilling accounted in large part for the year's $36,711,000 of intangible development expenditures.

★ **A five-point program** for economy in oil well drilling operations was outlined by AAODC President Jack H. Abernathy at the twenty-second annual meeting of the Petroleum Equipment Suppliers Association in Palm Springs, California. A solution to the tight economic problem lies in the supplier-contractor relationship, Abernathy said. He suggested that five steps toward improved drilling efficiency and economy are: (1) Research to improve drilling equipment; (2) Retirement of obsolete tools traded in on new equipment; (3) Reduction of suppliers' rig servicing expenses, such as daily rig calls by salesmen; (4) Re-evaluation of oil field supply credit policies, with a view to the financial responsibility of the debtor; and (5) where needed, suppliers' assistance to certain contractors in business administration problems such as cost accounting.

★ **Large drilling barge** has been moved onto a 5500 acre lease off the coast at Summerland, California, to begin core drilling operations for Standard Oil Company of California and Humble Oil & Refining Company. The companies paid $7,250,000 for the lease at a sale last January. Unit is the Pacific Driller No. 1—still looking for a "real" hole to drill.

"Chris Zeppa" is newest addition to Delta Marine Drilling Company's drilling fleet. The 180 by 60 by 50 ft submersible drilling barge was built in the New Orleans, Louisiana, yards of the American Marine Corporation. "Chris Zeppa," named after Delta Marine's vice president, is designed to accommodate a crew of 37 and operate in offshore depths up to 30 ft.

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Magna-Tector and Chemical Cutter Help Recover 6620' of Stuck Tubing

The use of the Magna-Tector in conjunction with McCullough's new Chemical Tubing Cutter has proved of great value to operators on tubing recovery jobs.

In this instance 2" O.D. tubing, in 5½" casing, was stuck. The Chemical Tubing Cutter was run and a cut made just above a packer set at 6620'. The tubing would not pull and the Magna-Tector was run, locating the lowest free point in the tubing at 6408'. The Chemical Tubing Cutter then made a second cut at this point.

Operator pulled the 6408' of free tubing from the well, washed over the remaining 200' down to the first cut above the packer and removed it from the well with no difficulty.

The two chemical cuts and one run with the Magna-Tector saved what could have been an expensive fishing job.

* * *

The jobs described above are certified to be true and accurate field reports of services rendered.

3½ Hours Use of Magna-Tector Saves Several Days Fishing Time

Sticking Medium Detected by McCullough Magna-Tector—Reveals Stuck Drill String Could be Recovered Without Back-Off and Washover Operations

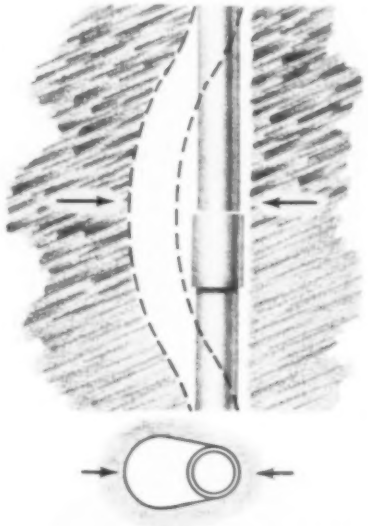
Here's a case where McCullough's Magna-Tector indicated that the entire string of stuck drill pipe could be recovered without time consuming back-off and washover operations.

Drilling at 4345', this Wyoming operator had started out of the hole with drill pipe and nine 6¼" O.D. drill collars when the string stuck. Pipe was worked for 24 hours. Oil was spotted at the drill collars for another 30 hours, without results.

At this point the operator decided back-off and washover operations were necessary. He called for McCullough's Magna-Tector (Free Point Finder) and String Shot Back-Off.

The Magna-Tector was run and readings indicated that the drill collars were working loose. It was recommended that the drill collars be allowed to soak in the oil awhile longer. Five hours later, and working the string frequently, the drill pipe came free.

The operator was very pleased with the information furnished by McCullough's Magna-Tector which saved an expensive back-off and washover job that might have consumed several days rig time.



Illustrated above is a typical key seat, one of the common causes for stuck pipe. If pipe is frictionally held by caving, sand or other material that can be affected by circulation, spotting with oil and working the pipe, the Magna-Tector may detect the condition and will report the progressive loosening as the pipe is freed deeper and deeper down the well.

Call McCullough—for fastest, most economical stuck pipe recovery

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Drilling

★ **Show of oil** will be seen by the Hollywood, California, movie colony very soon. Columbia Pictures has disclosed an oil drilling venture on its studio property to be carried out by Union Oil Company of California. Reports indicate that drilling will also be done on Paramount Studio and RKO Radio Pictures lots, just a few blocks away. A Union Oil spokesman has indicated that the first well would be drilled on the Paramount lot and if successful, horizontally drilled wells would be sunk from the same site to objectives under other two properties. Universal Consolidated studies already have a score of wells on its lots.

★ **One hundred wells** may be drilled by Shell Oil Company this year in Utah's Paradox and New Mexico's San Juan basins. The company has at least a dozen producing wells in southeastern Utah's Aneth field already. Shell has set up a new production division at Farmington, New Mexico, from which to supervise drilling and development activity in the Aneth area and in New Mexico's Bisti field. Shell and several other companies recently set up the Four Corners Pipe Line Corporation to construct and operate a line to take 60,000 bbl per day of crude from the fast developing Great Basins area.

★ **Exploratory offshore** drilling program in Lake Erie has been scheduled this year by the Texas Calgary Company of Abilene, Texas. Officials of the company met in Chatham, Ontario, in March to lay plans for the program. Firm has oil and natural gas exploratory licenses on Lake Erie acreage near an active gas producing area. Adjacent to the tract lie 34 producing wells of Consolidated West Petroleum Ltd. Gas reserves have been proved on land and under Lake Erie. Drilling is shallow, around 1200 ft, and relatively inexpensive. President of Texas Calgary, Ray McGlothlin Sr., estimates well cost at $15,000 to $20,000. Drilling expected to begin this summer.

★ **Digging under Houston's prison farm** will be legal, if oil operators have their way. Operators have asked the city treasury director to prepare lease specifications for the city's prison farm. Several have expressed interest in drilling on the 400 acre tract, only a few miles from the garbage dump oil production. The city has 10 wells producing on this property.

★ **A 40 well drilling program** has been planned by the one-year-old Inter-States Oil Company. The firm, which completed 16 wells in Southwest Texas in the past four months without a single duster, plans to add 40 more in 1957 in the Medina County area. Although the drilling is shallow (800 to 860 ft) average production is about 20 bbl daily per well. Company was incorporated last May and by November had accumulated proved reserves of 1,793,000 bbl. Newtex Drilling Company, Kerrville, Texas, under the same management, is sharing the same unusual success. It has drilled 143 wells with a record of 139 successful completions.

★ **Coastal Drilling Company,** Bakersfield, California, will be giving one of its drilling crews a cool summer. Coastal is sending a 14,000 ft rig to the Kenai Peninsula of Alaska to drill for Richfield Oil Corporation. First test is slated to go to about 8000 ft on a location some 30 miles north of the village of Soldatna in what is known as the Kenai Mo se Range, where Richfield, Union Oil of California and Ohio Oil Company share interest in a block comprising some 71,000 acres. The rig was slated to have arrived in Seward, Alaska, in mid-March.

CATC Group gets newest drilling tender, the "Orville L. Fisher," named after Continental Oil Company's vice president. Christened March 30 at Levingston Shipbuilding Company yards in Orange, Texas, the new tender measures 260 ft long and 54 ft wide. It contains facilities for housing the crew, a helicopter deck, water storage, mud pumping equipment, mud and cement storage. This new tender will go into drilling service in the Gulf where the CATC Group has 30 producing wells and 33 shut-in gas wells.

★ **New trademark** has been designed for Llano Drilling Company, Midland, Texas. The new mark suggests the company's modern search for oil to Coronado and his Conquistadores search for the "cities of gold" in the Llano Estacado (West Texas and New Mexico plains). Founded in 1951, the company operates deep rotary rigs in the Permian Basin and in the Gulf of Mexico.

★ **Pennant Drilling Ltd.,** a Tulsa, Oklahoma, owned contracting firm operating in Canada, has been acquired by Canadian Homestead Oils, Ltd., of Calgary, Alberta. The transaction will give Crescent Corporation, the principal stockholder of Pennant, a substantial stock interest in Canadian Homestead. Pennant operates five rigs. The acquisition will not affect operations, personnel or policies of either firm, officials say. Pennant was organized in 1952 by C. E. Wright (its president), F. M. Stevenson, F. T. Glasscock (officers of Signal Drilling Company and Signal Exploration Inc.), and Crescent Corporation.

★ **Kerr-McGee's Rig 40,** offshore unit that has been near capsizing, has been towed to Morgan City, Louisiana, successfully for repairs. Oldest submersible type unit in the Gulf, Rig 40 had been listing nearly 18 degrees in 20 ft water on a drilling rig location south of Morgan City. Preliminary inspection of the equipment indicated that damage was "slight." The $1,000,000 unit was put into service nearly nine years ago and has drilled more offshore wells than any other rig, reports indicate.

★ **"Mr. Gus" toppled** to the ocean floor in early April as a result of several unfortunate circumstances. The $3,500,000 mobile drilling platform, owned by C. G. Glasscock Drilling Company, had completed a 14,047 ft well for Sun Oil Company 35 miles south of Corpus Christi. Drilling crews watched helplessly, but safely, from a nearby crane barge as "Mr. Gus" slipped in high wind and rough water. The rig had been listing about two days as a result of a shift of the Gulf floor beneath its twin decks. Salvage operations were underway almost immediately to bring the platform out of the 35-ft waters where it lies about two-thirds submerged. Launched about two years ago, "Mr. Gus" is the largest mobile unit in the tidelands.

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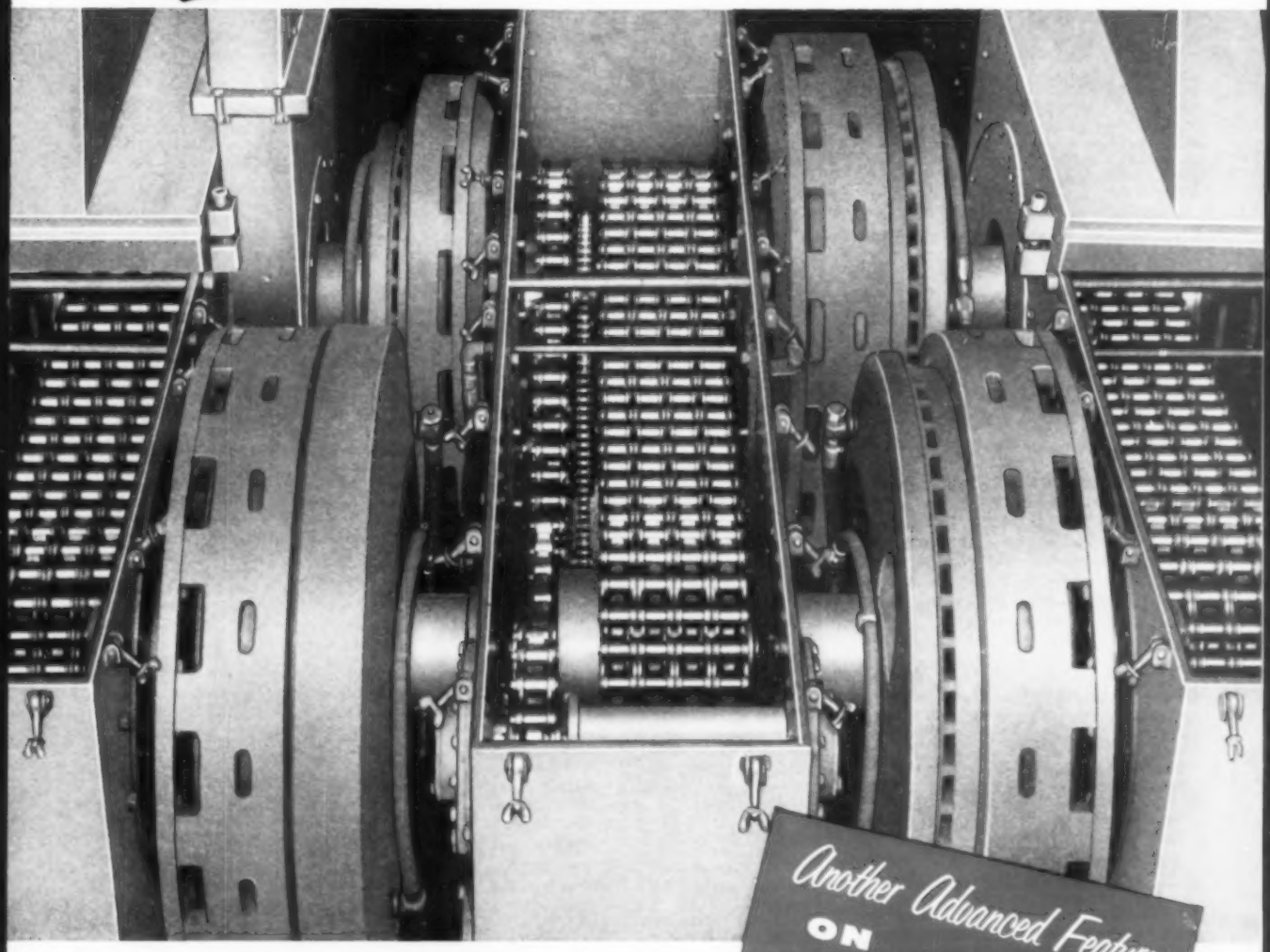

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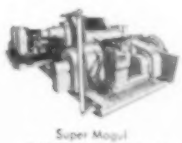

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7,500 Ft.—4½" Drill Pipe
8,500 Ft.—3½" Drill Pipe

THE MOST MODERN AND COMPLETE LINE OF DRILLING RIGS IN ALL THE WORLD

RUNNING TOUR with MEN in the INDUSTRY

▸ Promotion of three men to key positions in Continental Oil Company's foreign and exploration departments has been announced. **Harold R. Prescott,** manager of the exploration department's geophysical section, promoted to the newly created position of assistant manager of the foreign department. **B. G. Swan,** central region exploration manager for Conoco, promoted to manager of the geophysical section, succeeding Prescott at Houston. **B. B. Colley,** assistant manager of the geological section, promoted to central region exploration manager, succeeding Swan at Oklahoma City, Oklahoma.

▸ **Dr. Stephen W. Osborn** has joined the research department, organic chemicals division of Monsanto Chemical Company at St. Louis, Missouri. **Dr. Mervin D. Marshall** has joined the central research department, Monsanto's research and engineering division in Dayton, Ohio.

▸ Lion Oil Company, a division of Monsanto Chemical Company has announced the following promotions: **Frank Richardson,** assistant to the vice president of production and exploration, named manager, production and exploration department; **Robert I. Williams,** Rocky Mountain region manager, to assistant manager, production and exploration department; **Eugene L. Maxwell,** manager of central region, succeeds Williams, and **Robert P. Evans,** assistant manager southwestern region, succeeds Maxwell.

▸ **R. L. Harris** has joined Northern Natural Gas Producing Company as production engineer. He will supervise the drilling, completion and production of oil and gas wells in the producing company's Calgary, Alberta, Canada, district. He was associated with Sinclair Canadian Oil Company at Calgary as a petroleum engineer prior to joining Northern Natural Gas Producing, a subsidiary of Northern Natural Gas Company.

▸ **B. D. Donnell Jr.,** Denver, Colorado, has been promoted to assistant manager of Continental Oil Company's land section, with headquarters in Houston, Texas. Formerly Rocky Mountain regional land superintendent for Conoco at Denver, he succeeds **W. C. Stout,** who recently was promoted to manager of the land section. **Sam A. Brown,** Houston, assistant southern region land superintendent for Conoco, will succeed Donnell.

Roy M. Mays, Denver, has been promoted to assistant regional general manager of the southwestern region, with headquarters in Fort Worth, Texas. Formerly manager of Rocky Mountain region exploration department, he succeeds **W. O. Ham Jr.,** who recently transferred to Houston, Texas, as director of organization planning.

A. W. Black, Denver, has been promoted to regional geophysicist for Conoco's Rocky Mountain region. Formerly assistant regional geophysicist, he will continue to make his headquarters in Denver and succeeds **C. B. Smith Jr.,** who recently was promoted to Rocky Mountain region exploration manager. **C. M. Ferree,** division geophysicist for Conoco at Casper, Wyoming, will succeed Black in Denver.

▸ **Jack H. Marsee** has been appointed chief engineer for Loffland Brothers Company. He was with the drilling department of Phillips Petroleum Company and most recently has been division rig superintendent in West Texas. **W. E. Strittmatter** has been appointed administrative manager, finance and accounting. Prior to joining Loffland Brothers Company, Strittmatter was general office manager and chief accountant of Mid-Continent Supply Company. Other changes in the accounting department include **Dale Murphy** to chief accountant and **Marshall Underwood** to assistant chief accountant. **W. J. Weaver** has been elected secretary-treasurer, succeeding **R. F. McElhany.** Weaver has been director of purchases and assistant secretary-treasurer of the company for a number of years and will continue his supervision of the purchasing department. McElhany has been appointed personnel manager and will continue to handle the company's insurance department. **D. D. Thornbury** has been promoted to purchasing agent, and is succeeded as assistant purchasing agent by **John W. Trenary. John L. Cash** will head the traffic department.

J. H. Marsee

W. J. Weaver

W. E. Strittmatter

▸ **J. R. Carroll** has been appointed an assistant manager with offices at Caracas, Venezuela, of the producing division of The Texas Company's foreign operations department (Western Hemisphere and West Africa). He was formerly manager of the Texas Petroleum Company's Venezuelan producing division, at Caracas. **R. E. Wright** has succeeded Carroll as manager of Texpet's Venezuelan producing division. Wright was formerly senior assistant manager. Other appointments in Texpet's Venezuelan producing division are: **Paul Youngmeyer,** formerly an assistant manager at Calgary, Canada, of Texaco Exploration Company, to assistant manager (exploration); **J. M. Patterson,** from chief geologist to assistant to the manager; **J. E. F. Caston,** to chief geologist, and **Harvey Stein** to assistant chief geologist.

M. N. Broughton has been appointed staff geologist in the New York offices of Texas Company's foreign operations department. Broughton has been staff geologist of Texaco's domestic producing department.

▸ **J. William Schmotzer,** regional geologist, has been promoted to assistant chief geologist of Arkansas Fuel Oil Corporation.

▸ **Seymour G. Hootkins** has resigned as executive vice president and director of Ryan Consolidated Petroleum Corporation to become an independent oil operator. Before being associated with Ryan, he was an independent and is credited as one of the co-discoverers of the Jefferson field in Marion County, Texas.

▸ **Dr. H. C. G. Knipscheer** has joined the Calgary, Alberta, offices of Alex McCoy Associates, Inc., Tulsa, Oklahoma, geological consulting firm, as a geologist.

▸ **Jack E. Hughes** is now with the Drilling and Exploration Company, as geologist. He previously was associated with Atlantic Refining Company and D. D. Feldman Oil & Gas.

▸ Eight geophysicists have been nominated for office in the Society of Exploration Geophysicists. For president, **O. C. Clifford Jr.,** chief geophysicist for The Atlantic Refining Company, Dallas, Texas, will oppose **H. M. Thralls,** president of Geo Prospectors, Inc., Tulsa, Oklahoma. **Otis B. Hocker,** manager of the geophysical division of The Texas Company, Houston, and **Ben F. Rummerfield,** executive vice president of Century Geophysical Corporation, Tulsa, have been nominated for vice president. For secretary-treasurer **Howard E. Itten,** president of Empire Geophysical, Inc., Fort Worth, will be opposed by **Curtis P. Harkins,** vice president of Independent Exploration Company, Houston. **L. Y. Faust,** geophysical supervisor for Amerada Petroleum Corporation, Tulsa, will oppose **E. J. Stulken,** chief seismologist for Geophysical Service Inc., Dallas, for the two-year term of editor.

▸ **Dr. R. L. Slobod,** professor and head of the department of petroleum and natural gas at the Pennsylvania State University, has been appointed to the Research Committee of the Interstate Oil Compact Commission by Governor Raymond Gary of Oklahoma, chairman of the Compact Commission. Dr. Slobod was recommended to be Pennsylvania's representative on the Committee.

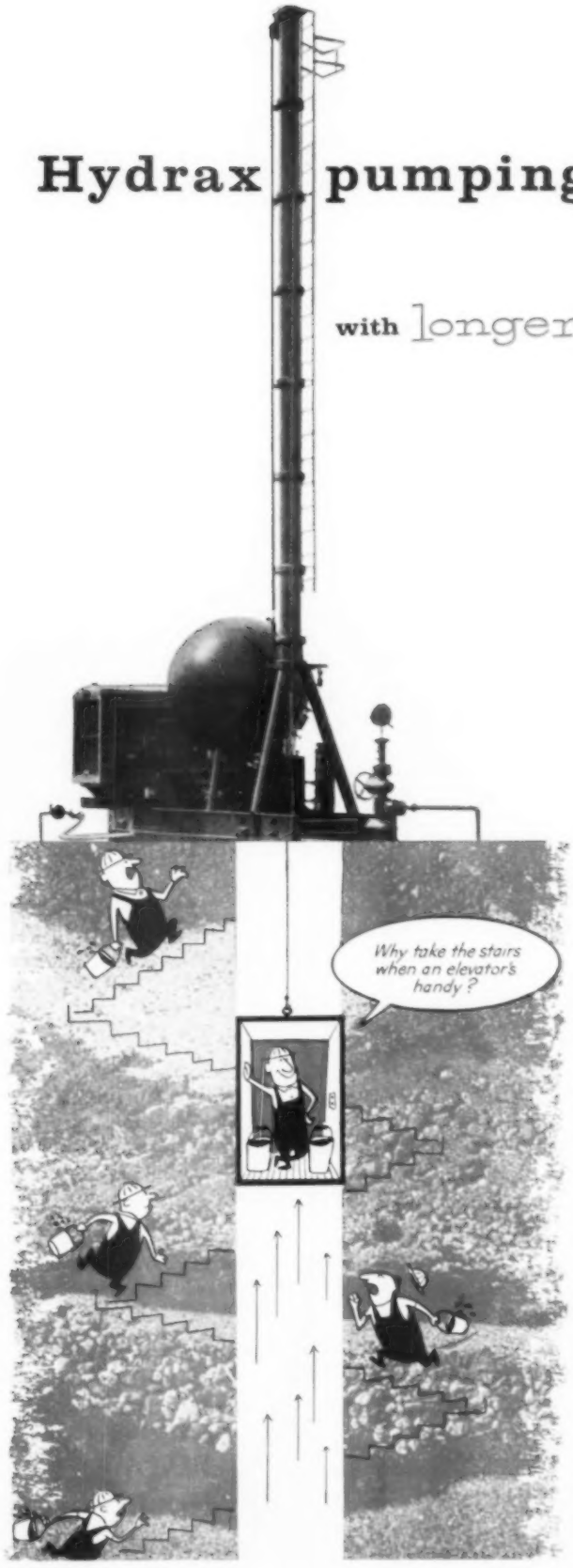
▸ **Arthur A. (Duke) Curtice** has been named president and general manager of Signal Exploration Company, foreign subsidiary of Signal Oil and Gas Company. Curtice's headquarters will be in Caracas, Venezuela. His election will enable **Garth Young,** who has been president of Signal Exploration since its start in 1955, to return from Caracas to his post in the United States as vice president and head of Signal Oil's foreign department.

▸ **George B. Jenkinson** has opened offices in Tulsa, Oklahoma, as an independent oil operator and consultant. He recently retired from Pan American Petroleum Corporation after more than 42 years' service with the company and its affiliates. He was unitization manager.

▸ **T. D. Langford,** assistant division manager in Murphy Corporation's Billings, Montana, office, has been transferred to the home office in El Dorado, Arkansas, and promoted to the position of land manager.

Hydrax pumping units raise profits

with longer... smoother strokes



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And they do it with a normal stroke of 26½ feet . . . the most effective in the industry. Their seven long strokes/minute actually outproduce the thirteen strokes/minute of the biggest beam unit. There's less wasted motion in rod stretch, and volumetric efficiency is greatly increased.

The slower, smoother action of these big counterbalanced pumpers virtually eliminates sucker rod failures . . . increases rod life to eight times normal expectancy. Rod stresses can be increased as much as 30%, enabling operators to use larger bore pumps to move greater volumes of fluid. Maximum load capacity is 32,000 lb.

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▸ **Gene L. Weger,** assistant division production superintendent for the Denver, Colorado, division of Sinclair Oil & Gas Company, has been promoted to division production superintendent. Weger succeeds **J. A. Jackman** who resigned from Sinclair Oil & Gas to accept a post with Sinclair Pipe Line Company at Independence, Kansas. **Ford P. Haskin,** production superintendent for Sinclair's Montana and Wyoming districts, headquartered at Casper, Wyoming, succeeds Weger at Denver. **Troy C. Kadel,** production superintendent of the Colorado-Nebraska district at Fort Morgan, Colorado, was transferred to Casper, and succeeds Haskin. **Aubrey B. Parker,** district production foreman at Powell, Wyoming, succeeds Kadel.

▸ **Kenneth W. Paul,** formerly geologist with Shell Oil Company, has joined the Houston, Texas, offices of H. Zinder & Associates, Inc. as geological engineer. He has been active in exploration activities in the Permian Basin, Rocky Mountain and Gulf Coast areas.

K. W. Paul

J. E. Warren

▸ **J. Ed Warren,** formerly of Midland, Texas, has been promoted to senior vice president of the First National City Bank of New York. He joined that institution several years ago as a vice president in charge of its oil department. Warren was head of Carl B. King Drilling Company and a partner in King, Warren & Dye, independent oil operators. He still retains his interests in the latter concern.

▸ Trunkline Gas Company of Houston, Texas, has announced the opening of a production and supply field office in Corpus Christi, Texas, and the appointment of **John D. Gauntt Jr.,** as district geologist for the Corpus Christi area. Gauntt, a native of Athens, Texas, joined Trunkline Gas from Skelly Oil Company where he was assistant Corpus Christi district geologist.

▸ **Lee S. Osborne** has been elected to Union Pacific Railroad Company's vice presidency in charge of oil development. In addition to heading oil and gas operations in five states, Osborne will have

L. S. Osborne

William Reinhardt

supervision of the exploration and development of mineral deposits owned by the railroad. **William Reinhardt** retires as vice president of the oil development department after 20 years of service.

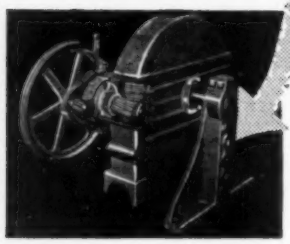
▸ **K. W. Kendrick** has been elected regional vice president of Standard Oil Company of California, Western Operations, Inc., for Southern California. He will continue as Los Angeles regional manager of wholesale sales. As regional vice president, Kendrick will direct activities in the fields of stockholder, community and industry relations.

▸ **Neil S. Whitmore** has succeeded **Robert B. LeFever** as district superintendent for Pan American Petroleum Corporation at Lubbock, Texas. LeFever has been transferred to Calgary, Alberta, Canada, to become assistant division production superintendent. Whitmore moves to Lubbock from Midland, Texas, where he had served as assistant district superintendent.

▸ The new officers of the Billings Petroleum Section, Society of Petroleum Engineers of AIME are: **Don Bishop** of Lane Wells, Inc., director; **Maury Anderson** of Northern Pacific, first vice chairman; **M. E. Welbourn** of Shell Oil Company, director; **Earl J. Whitaker** of Northern Pacific, chairman; **Gary Brown** of Mobil Producing Company, secretary-treasurer; **Joe McClure** of Dowell, Inc., second vice chairman, and **W. A. Scott** of Shell Oil Company, retiring chairman who is now a director.

▸ **J. P. D. Hull,** who has been an important figure in the management of the American Association of Petroleum Geologists since 1926, has received that organization's highest honor, the Sidney Powers Medal. Hull accepted the award April 2 during the forty-second annual meeting of the association in St. Louis, Missouri.

13 SIZES



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Have Done a Good Job for More than 37 Years!

The first JENSEN JACKS made in 1919 set the standard in the oil industry for economy and dependability . . . and the JENSEN JACKS made today are living up to this 37-year-old reputation.

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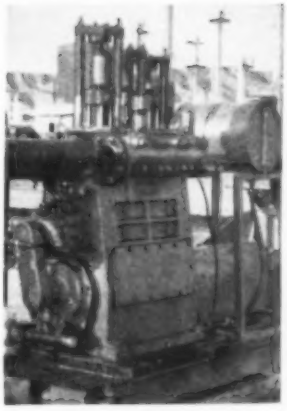
Downtime, due to pump failure, is always a costly item. It takes the reliability and freedom from maintenance found in an Aldrich Pump to eliminate downtime under continuous, heavy duty pumping operations. Top performance under these conditions has earned Aldrich its reputation for building pumps of highest quality and dependability.

The tougher the job . . . the more important it becomes to take advantage of our wide experience in providing the petroleum industry with pumps for water flood, pipeline, gasoline plant, hydrocarbon injection or petrochemical service.

In the less critical jobs, too . . . it makes sense to call Aldrich. The simplicity of the Aldrich Direct Flow design, with fluid-end sectionalization, offers substantial economies in both operation and maintenance.

A copy of our new condensed catalog, showing the line of Aldrich Pumps is yours for the asking. Write for Data Sheet 100. The Aldrich Pump Company, 26 Pine Street, Allentown, Pa.



Shown above is one of a number of Aldrich 5" stroke, Triplex Pumps installed at a major west coast water injection project. These pumps are currently handling 35,000 bbl daily at injection pressures of 1,000 psi.

THE ALDRICH PUMP COMPANY

Field parts stock is available in **Carmi, Illinois; Charleston, W. Virginia; Houston, Texas; Los Angeles, California; Odessa, Texas; Tulsa, Oklahoma**

American Association of Petroleum Geologists executive committee for the coming year are: William J. Hilseweck, secretary-treasurer; Theo. A. Link, past president; Graham B. Moody, president; Byron W. Beebe, vice president, and Sherman A. Wengerd, editor of the AAPG Bulletin. Nearly 3000 attended the St. Louis, Missouri, sessions of the forty-second annual meeting of the AAPG and simultaneous meetings of the Society of Economic Paleontologists and Mineralogists. New president of the SEPM is R. V. Hollingsworth.

▸ **Jack H. Abernathy,** president of the American Association of Oilwell Drilling Contractors, has been named a member of the National Petroleum Council's Committee on Petroleum Productive Capacity. He is vice president of Big Chief Drilling Company, Oklahoma City, Oklahoma.

▸ Five oilmen from Kansas, Oklahoma, and the Texas Panhandle have been selected to receive "Citations for Service" from the American Petroleum Institute for outstanding service to the industry and to the Mid-Continent district of the API division of production. They are **D. L. Trax,** Topeka, Kansas; **Fred Neslage,** West Pampa Repressuring Association, Pampa, Texas; **J. H. Field,** Sohio Petroleum Company, Oklahoma City; **Ross Bolton,** Crescent Corporation, Tulsa, and **L. E. Fitzjarrald,** Phillips Petroleum Company, Bartlesville, Oklahoma.

▸ Twelve seismic and gravity specialists have been transferred to Bolivian and Brazilian crews of Seismograph Service Corporation. **Michael W. Tyrrell** will lead a gravity party of seven men to Bolivia. The six others include **John W. Chovin,** gravity computer, **Frederick W. Doll, Robert S. Plumb,** and **Robert C. Oberg,** gravity surveyors, **Clinton W. Brownell,** gravity meter operator and **Herbert E. Smith,** gravity mechanic. The five men transferred to the Brazilian crews include party chief **Anthony J. Kochendorfer, Richard W. Dunbar,** observing supervisor, **Charles G. Laird** and **Philip A. Rehil,** observers and **R. W. Ivey,** driller.

D. J. Kartman, research engineer for Seismograph Service has left for Paris, France, to assist SSC's French subsidiary, Compagnie Francaise de Prospection Sismique, in placing CFPS's first set of Carter Magnetic seismic equipment into operation. **E. B. Lindsey** has returned to the United States after more than 10 years abroad as geophysical supervisor for SSC and its foreign subsidiaries. He is yet to be assigned a post in this country.

▸ **Frank G. Kozak** has been promoted contact manager of Garvey Drilling Company, and **Bill Garms** made Rocky Mountain contact representative. Garms was previously associated with ACC Diamond Coring. He succeeds Kozak who represented Garvey Drilling Company in Denver, Colorado. Kozak, in his new position, will assume the responsibility for the direction and development of Garvey Drilling's contact program. In addition to Garms at the Denver office, the company is represented in Wichita, by **James H. Gardner Jr.** and in Oklahoma City by **Neal Colby.** Kozak will work out of the central field office at Great Bend, Kansas.

▸ **Victor Oppenheim** and **Glenn O. Briscoe** have opened offices as consultants, petroleum and mineral explorations, for the Mid-Continent area, Central and South America, in Dallas, Texas.

▸ **S. J. Matthews** of Oklahoma City, Oklahoma, has been appointed assistant division engineer for Cities Service Oil Company's South Oklahoma-North Texas production division. He was in charge of test well drilling in the Rocky Mountain area from 1950 to 1953, and was transferred back to Oklahoma in 1953, where he served as district engineer. **R. T. Widney** of Bartlesville, Oklahoma, has been named superintendent of gas operations for Cities Service production division.

▸ **J. C. Farris,** who has been district engineer in the East Texas district offices, Longview, Texas, for Pan American Petroleum Corporation, has been made field superintendent at Greggton, Texas. He replaces **C. V. Campbell,** who has been transferred to Brownfield, Texas, as field superintendent. **F. L. Nabors,** formerly senior petroleum engineer in the Tulsa, Oklahoma, offices, succeeds Farris as East Texas district engineer. **W. A. Kimbrough** was named assistant district superintendent in the Midland, Texas, district offices. He succeeds **N. S. Whitmore,** recently promoted to district superintendent at Lubbock.

▸ **Ben P. Piepgrass,** formerly manager of the San Antonio, Texas, offices of Midstates Oil Corporation, has been transferred to Shreveport, Louisiana, as manager of operations in East Texas, Arkansas, and the northern half of Louisiana. **V. I. Irby,** formerly assistant manager at San Antonio, has been promoted to manager of that office, supervising activities in the Texas Gulf Coast and South Texas areas.

▸ **Jack M. Little,** Corpus Christi, Texas, oilman and attorney, has been appointed to head land department activities in the Corpus area for Trunkline Gas Company of Houston, Texas.

▸ **O. N. Miller** has been appointed a vice president of Standard Oil Company of California. He has been a vice president of Standard Oil Company of California, Western Operations, Inc., the company's operating subsidiary in seven western states, Alaska and Hawaii. **Fred Powell** has been appointed a vice president and director of the subsidiary.

G. F. Watford

▸ **George F. Watford,** Houston, Texas, geologist, has been named manager of exploration for Commonwealth Oil Company. Before joining Commonwealth, he was associated with Pan American Oil Company for nine years. He joined the firm in 1948 as a junior geologist, later becoming the company's Houston district geologist.

▸ **Gordon H'llhouse,** former senior engineer at Midland, Texas, has been named district engineer for Sunray Mid-Continent's production department, South Texas district at Corpus Christi, Texas. Senior engineer **Herman Owens Jr.** was promoted to district engineer at Lafayette, Louisiana, headquarters for the South Louisiana district. **Walter Kellogg,** former reservoir engineer at the Tulsa, Oklahoma, office, was named district engineer for the tri-state district with headquarters at Lewisville, Arkansas. **Tom Brinkley** of the Tulsa office will replace Kellogg. **W. D. Elliott,** former district engineer for the tri-state area has been transferred to the Oklahoma district at Oklahoma City.

▸ **J. M. Barton** has been named vice president of Northern Natural Gas Producing Company, a subsidiary of Northern Natural Gas Company. He was promoted from exploration manager.

J. M. Barton

C. F. Horton Jr.

▸ **Charles F. Horton Jr.** has joined Wheless Drilling Company, Shreveport, Louisiana, as production engineer. He has been with Union Producing Company in their New Orleans and Shreveport districts.

THE OASIS—

A gathering spot for NOMADS

L. B. Meaders

Abbott Sparks

Nomads Meeting Dates and Secretaries

New York Chapter, first Monday of the month, Hotel Roosevelt, New York. Executive Secretary, E. W. Hoeppner, in care of Hughes Tool Co., Room 903, 45 Rockefeller Plaza, New York 20, N. Y.

Houston Chapter, second Monday. Ye Old College Inn, Houston, Texas. Executive Secretary, Harry E. Estes, P. O. Box 18171, Houston 23, Texas.

Los Angeles Chapter, second Wednesday, Jonathan Club, Los Angeles, California. Executive Secretary, W. A. Sawdon, P. O. Box 848, Hollywood 28, Calif.

Tulsa Chapter, third Friday, Mayo Hotel. Executive Secretary, E. L. Thomas, P. O. Box 3771, Tulsa 9, Okla.

Dallas-Fort Worth Chapter, first or second Monday. Secretary, R. B. Gilmore, DeGolyer & MacNaughton, 5625 Daniels, Dallas, Texas.

New Nomads Heads Picked

L. B. (Preach) Meaders, president of Halliburton Oil Well Cementing Company, has been named to the chairmanship of the National Board of Regents—NOMADS, and Abbott Sparks, Jr., vice president of The Petroleum Engineer Publishing Company, is the new secretary-treasurer of the society.

Meaders and Sparks were elected by the regents from the New York, Los Angeles, Tulsa, and Houston chapters. The new officers are the regents of the Dallas-Fort Worth chapter.

Starting with Halliburton in 1928 as a truck driver, Meaders worked his way up the ladder the hard way to his present post as head of Halliburton operations. He is director, trustee or member of many business, fraternal and organizational clubs in both Dallas and Duncan. He is a graduate of the Harvard Advanced Management Program (1951) and a Sigma Chi. He acquired the nickname, "Preach," from his minister father.

Sparks grew up in Pauls Valley, Oklahoma, studying geology at Oklahoma and Colorado universities, and was graduated from OU with two bachelor degrees in geology and literature.

Following two years in the South Pacific in the Navy, he joined a Dallas advertising firm, and later DRILLING Magazine. In 1948 he became associated with THE PETROLEUM ENGINEER.

Foreign guests at the March 13, 1957, meeting of the Los Angeles Chapter of Nomads. Shown here are (standing): Chas. H. Looper of I.D.C. from Holland; George H. Farver of D & E from Sicily; Jim Bodine of Cerro de Pasco Corporation from Peru; Lester Maupin of Cal-Tex from Sumatra; Ralph Aldridge of Cal-Tex from Sumatra; Harold F. Allen of Transworld Management Corporation; Dr. George Wettstein of Dresser Industries from Switzerland; Larkey Watkins of Standard Vacuum from Indonesia; (seated) G. E. Porter of Camdrill International from Egypt; Severino Lopes Baptista of Petroleo Brasileiro from Brazil; Manoel Borges Neves of Petroleo Brasileiro from Brazil; H. L. Riley of Santa Fe Drilling Company from Iran; John J. Donnelly of D & E from Dhofar.

Houston Chapter Gets Near East Briefing

. . . LA Nomads Take Three New Members

Near East was brought a little nearer to Nomads members and guests at the Houston Chapter's regular monthly meeting March 11 at the College Inn. Virgil Lee, speaker of the evening, gave an interesting talk on a recent trip made to the Near East. Visitors at the meeting were: Steve R. Pounds, Trinidad Oilfield Service, Trinidad, BWI; Martin Mears, superintendent, STA, Turkey; Martin Newell, Tidewater Oil Company, Los Angeles; Lee, Houston (speaker); R. L. (Red) Foster, Socony-Mobil Oil Company, New York; J. C. Robbins, Iran Oil Company, Teheran, Iran.

Induction ceremonies at the March 13, 1957, meeting of the Los Angeles Chapter of Nomads. From left to right, Bill Brooks of Byron Jackson Tools, Inc., Ritual Master; George Ruppert of Oil & Gas Journal, Herb Klepfer of Baash-Ross Tool Company, and Hilmer Olson of S. R. Bowen Company, inductees; Ox Morgan of Falcon Products, Inc., of the Ritual Committee.

OPERATOR JUST CALLED...SAID SEECO-MUL DID SUCH A GOOD JOB ON HIS LAST WELL HE WANTS TO USE IT IN THIS HOLE TOO!
"SEECO-MUL MAKES A GOOD MUD BETTER"
Garvin DRILLING COMPANY

New York Nomads Host 18 Guests . . .

Los Angeles Group Hears Airplane Talk

Airplane electronics was discussed by J. E. Lynch of Hughes Aircraft Company (center), who addressed the Los Angeles Chapter of Nomads at the regular monthly meeting, March 13, 1957. To the left is Charles McLaren of Hughes Tool Company and to the right, Tom Ashe of Globe Oil Tools Company, who introduced the speaker.

Guests galore at the March 4 regular monthly party of the New York Chapter of Nomads! Shown here are the group of out-of-town and foreign guests that met with the Nomads. Seated are: John Houlden, Mobil Oil, Calgary, Canada; Arle C. Hatfield, Bolivian Gulf Oil Company, Cochabamba, Bolivia; W. H. (Buster) Becker, Atlas Pipe Inc., Houston (member of Houston Chapter); Wallace W. March, International Drilling Company, Rome, Italy; A. B. Moore, Mobil Overseas Oil Company, Paris, France; Dabney Park, Socony-Mobil Oil Company de Venezuela, Caracas, Venezuela. Standing are: L. T. Smith, Colombian Petroleum Company, Cucuta, Colombia; Carl Egner, Oil Well Supply Div. United States Steel Corporation; H. W. Mack, Mene Grande Oil Company, Barcalona, Venezuela; C. B. Guerber, The Wheland Company, Chattanooga, Tennessee; Gordon L. Smith, Jr., The Wheland Company, Chattanooga, Tennessee; William G. Heltzel, consulting engineer, Tulsa, Oklahoma; Doug Cairns, Mobil Oil of Canada; J. M. Rupert, Standard Vacuum Oil Company, Palembang, Indonesia; H. E. McAuliffe, Mobil Oil Company de Colombia, Bogota, Colombia; M. R. Garrison, International Drilling Company, Rome, Italy; W. P. Elliot, Barden International Ltd.; J. H. Sawyer, Esso Standard Oil S.A., Havana, Cuba.

use CROSSETT Seeco-Mul *for better drilling... better completions-*

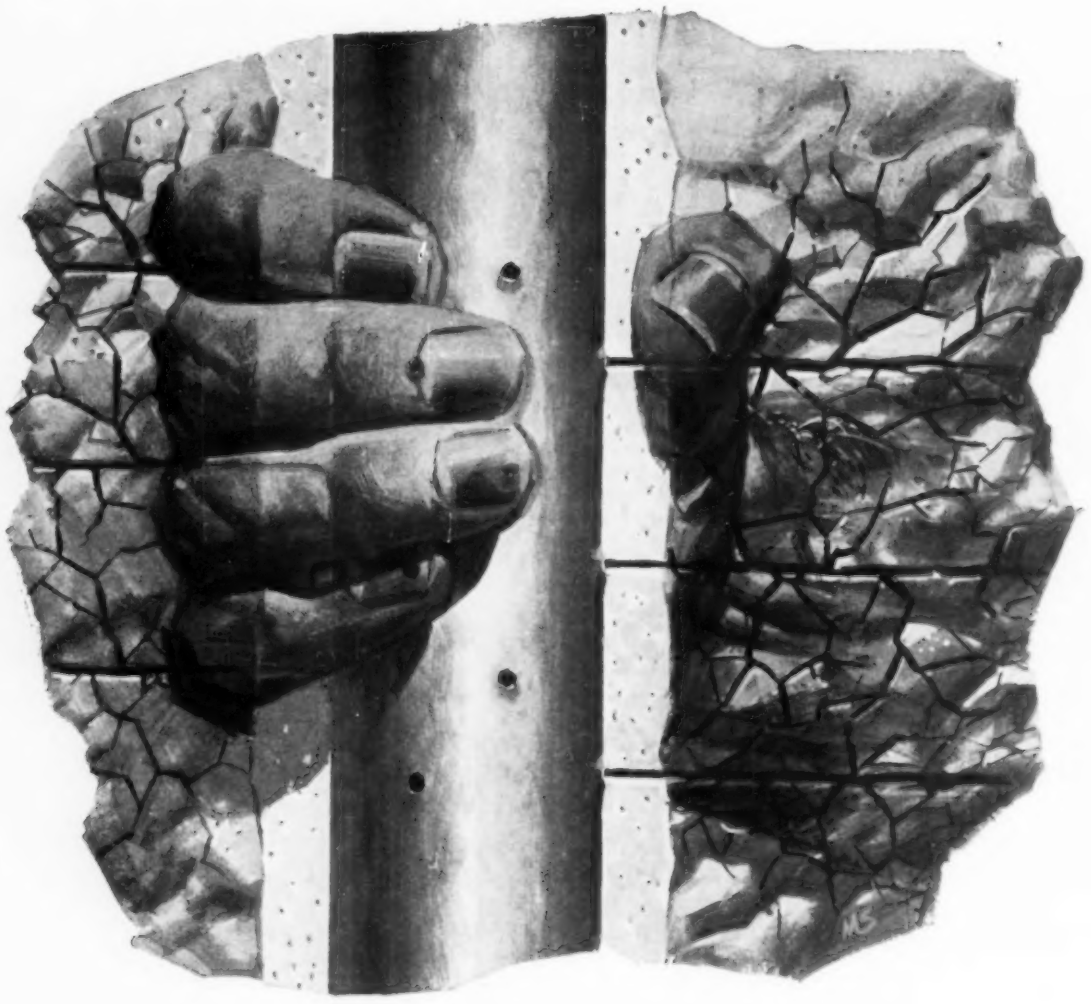
Next time you're on a tough well, convert to a Seeco-Mul emulsion mud and watch your hole troubles disappear. Seeco-Mul makes faster drilling, reduces friction on the drill stem, provides a higher velocity of fluid on bottom, and allows pump pressures to be lowered and more evenly sustained. A Seeco-Mul mud also forms a tough, thin wall cake, it protects the pay zone from water, and reduces interfacial tension. Seeco-Mul is exceptionally stable at high temperatures, it is readily soluble in cold water, and it works well at high pressures. You will minimize hole enlargement, too, and your well will come in on production better, easier, and cleaner.

Any qualified mud engineer can use Seeco-Mul without extra equipment or special instructions. Just add it to the system (usually 2 to 3 lbs./Bbl.) through the hopper or the mud hog suction over one or two circulations. Seeco-Mul is packaged in sturdy, moisture-proof 50-pound sacks that are easy to handle around the rig.

Your local mud dealer will be glad to tell you about many other advantages of a Seeco-Mul emulsion mud, or write to us for illustrated literature and a lab sample. We'll be glad to send you full particulars without obligation. Crossett Chemical Company Division of The Crossett Company, P. O. Box 271, Crossett, Arkansas.

get a better hole with CROSSETT Seeco-Mul *emulsifier*

THE WEATHERFORD TECHNIQUE



Fracture the formation . . . not your cement job

Conditions may demand high-pressure fracturing or acid treatments for your well. But can your cement job take it? Only a good cement job will permit maximum exploitation by means of today's well stimulation methods.

A good primary cement job forms a strong, *permanent* bond between the formation and the casing—one that won't fail, come high injection rates, mud cleanout acids, or high-powered perforating.

Proper hole-conditioning, lower pumping pressures, and freedom from lost circulation are problems faced in getting a good primary cement job. The Weatherford Technique has been developed to control these and other factors, from the moment the drill pipe is laid down until the cement is in place. Years of experience, highly-trained men and the best in equipment are behind your cement job; *place it in good hands.*

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OIL TOOL CO., INC.

GENERAL OFFICES: 5920 Navigation Blvd., Houston, Texas

How McEvoy uses "CONTROLLED FRICTION" to prevent casing failures

Engineered into each McEvoy Casing Hanger is the exclusive "Controlled Friction" principle, developed by McEvoy to permit hanging of casing to its full joint coupling strength without damage to the casing. This principle is your assurance of maximum safety and economy.

McEvoy "CF" Casing Hangers securely grip the casing with sharp inner teeth while precision-made outer teeth control the slip bowl friction, automatically limiting downward movement of slips in the bowl. These casing hangers effectively solve the problem of reconciling high load capacity and good initial pipe bite by increasing the friction between slip and bowl as the casing load increases, stopping downward casing travel *before* the casing is damaged by the slips.

Hydraulic and mechanical loads are completely separated by use of two separate and independent support areas in these McEvoy Hangers. Pipe bottlenecking is completely eliminated and casing pressures, test pressures, or high pressure remedial work cannot load the slips or change their pipe load capacity.

McEvoy casing hangers for all wells

McEVOY "CB" CASING HANGER . . . designed for medium and medium-heavy casing strings . . . combines "Controlled Friction" slips and "Shielded Seal" pack-off with maximum economy . . . will safely hang casing to full short joint coupling strength.

McEVOY "CB-2" CASING HANGER . . . fits the space-saving, low-cost Type "C" Casing Head. Provides economical, medium duty, wrap-around, automatic set and seal service . . . may be wrapped around the pipe and dropped through the preventers to provide automatic sealing with very low pipe load and to safely support the pipe.

McEVOY SD-2 CASING HANGER . . . the complete answer to every deep, high pressure, heavy string need. May be wrapped around the pipe and dropped through the preventers for automatic set and seal . . . will safely support any casing string that can be picked up in the derrick.

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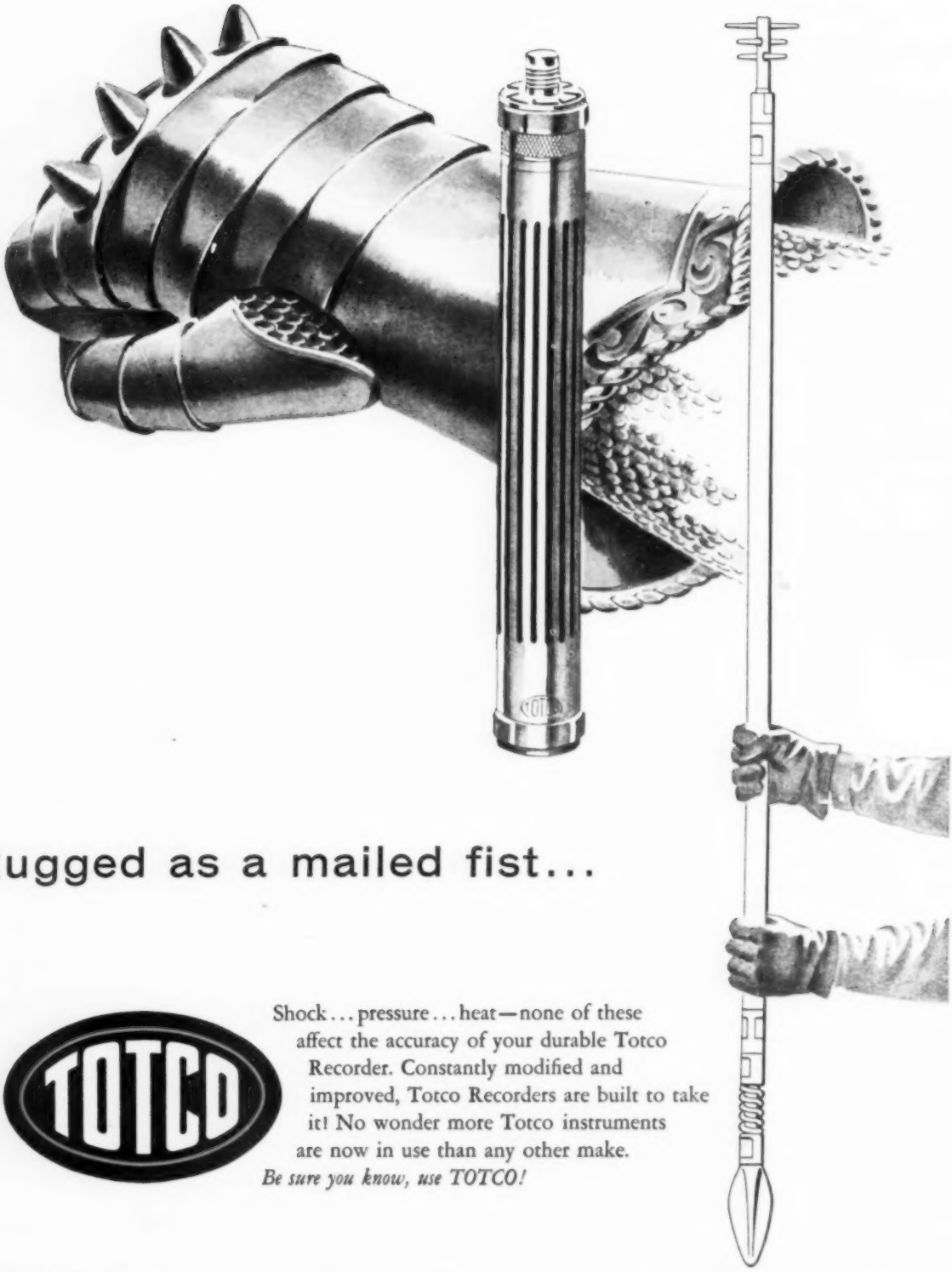

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Shock... pressure... heat—none of these affect the accuracy of your durable Totco Recorder. Constantly modified and improved, Totco Recorders are built to take it! No wonder more Totco instruments are now in use than any other make.

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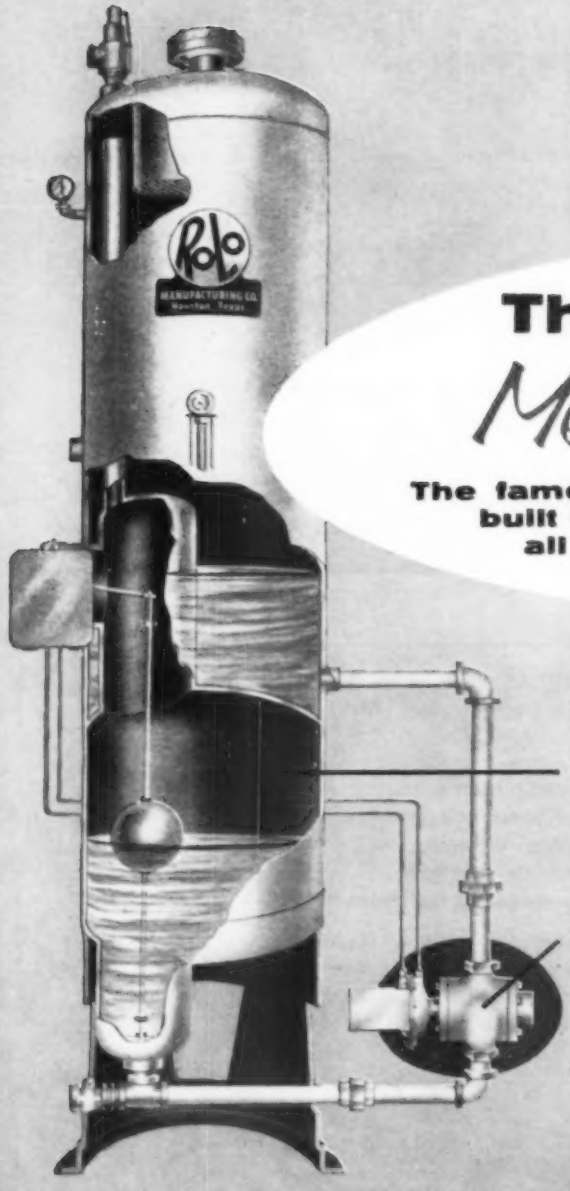
Why it pays to continuously meter the production from each well, individually.....

Continuous separation and metering of oil, water and gas at the wellhead provides the operator with essential information that can be accurately derived in no other way. Continuous metering keeps a **constant** check on a well's production, indicating trouble and the need for treatment **when trouble happens**, not weeks (and dollars) later when noticed in a well test. Continuous, accurate records on individual wells are also invaluable for reservoir studies and future planning.

Besides these advantages, continuous well metering allows great savings in flow lines and tankage; long flow and test lines for individual wells become unnecessary. This means savings in equipment and maintenance, and takes a load off field personnel.

Rolo now offers the unit ideally suited to individual well separating and metering . . .



The ROLOCHECK *Metering Separator*

The famous and proven ROLOCHECK Meter, built right into an efficient separator— all for little more than you'd pay for a separator alone.

The ROLOCHECK Metering Separator automatically separates and meters production **accurately**, with simple and gadget-free efficiency. And ROLOCHECK Metering Separators offer important features exclusive with Rolo:

- **ROLOCHECK METERS** — Field-proven in over a thousand installations. Levels controlled in reduced-area necks, assuring maximum accuracy. Meters alternately fill and dump exactly calibrated volumes. Minimum internals and **simplest control system.** New, rugged counter assures exact counting.
- **ROLO NEUTRAL POSITION 3-WAY VALVES**— These new valves allow only one port (meter inlet or outlet) to be open at one time. At no time, even during the valve-switching operation, can both ports be open at once. Thus, liquid **cannot** bypass the meter!
- **TWO-PHASE AND THREE-PHASE UNITS**— Two-phase units separate total liquid and gas, metering total liquid. Three-phase units have **two** ROLOCHECK Meters built in, with a free water knockout, so that oil and free water are each metered . . . all this in one vessel.. Rolo Automatic Samplers are available for oil lines.
- **ALL SIZES AND WORKING PRESSURES**

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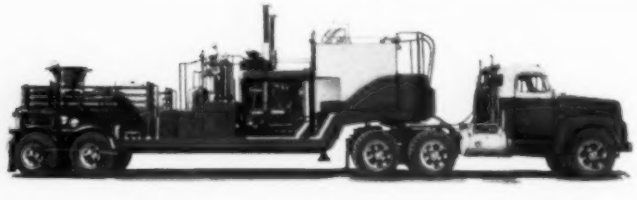
HOW HALLIBURTON PUTS CHEMICALS AND TOOLS TO WORK FOR OILMEN

Halliburton Chemical Services have aided oilmen in putting chemistry to work for more profits in many ways. Crevice enlargement by fast or slow acid action for improvement of oil flow. Releasing stuck drill pipe. Emulsion breaking. Mud removal to stimulate new wells and revive old ones. Well cleanout before fracturing or cementing, to improve results.

Treatments are made faster, more effective, less costly, by Halliburton's full line of "perpetually engineered" down-hole tools for wire line or tubing. Treatments are backed by decades of Halliburton research on oil well chemistry, creator of greater profits for oilmen.



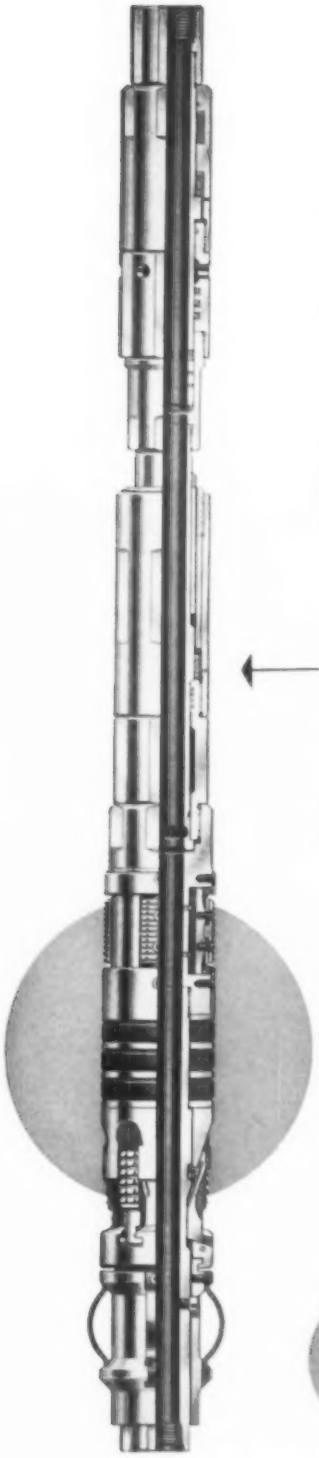
HALLIBURTON

OIL WELL CEMENTING COMPANY

DUNCAN, OKLAHOMA

FOR EFFECTIVE WELL TREATMENTS... HALLIBURTON'S "PERPETUALLY ENGINEERED" PACKERS

When a well owner calls a Halliburton crew for chemical treatment, fracturing or squeeze cementing, he gets Halliburton tools and treating materials, constantly improved by research to give the customer better results. Among them are...

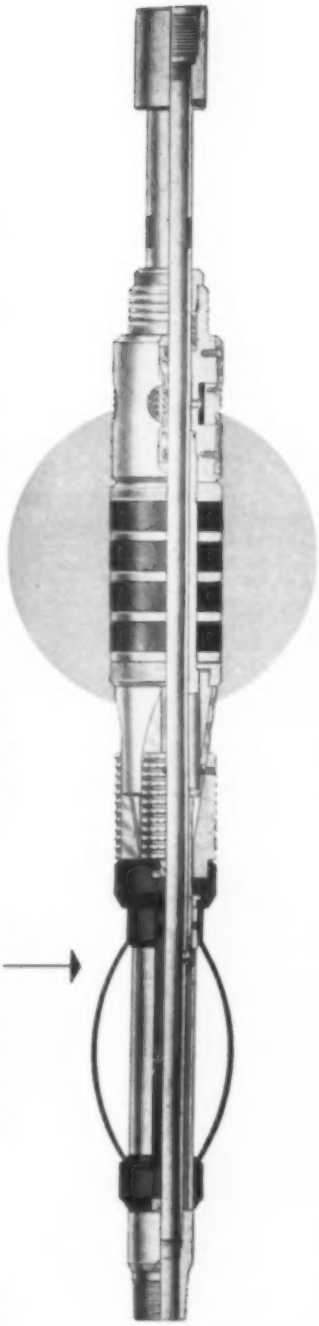


RTTS PACKER (RETRIEVABLE-TEST-TREAT-SQUEEZE)

RTTS PACKER (Retrievable-Test-Treat-Squeeze)... can do four jobs on a single trip into the well... acidizing, fracturing, testing, squeeze cementing. Operated by simple tubing manipulation. Full opening mandrel permits treatment with large fluid volumes or passage of tubing-type perforating gun. Safety joint with drillability features for squeeze cementing. Circulating valve equalizes tubing and annulus pressures at Packer when desired.

TYPE "HM" RETRIEVABLE PACKER... quickly isolates zone to be acidized, fractured or tested. Hydraulic and mechanical slips hold this full opening packer firmly in place. Set by weight of tubing, released by picking up. Can be reset for multiple treatments many times without coming out of hole. Circulating valve on packer locks open while running in hole, closes as packer is set. May be opened at any time by raising tubing.

MCA... Halliburton's famous Mud Cleanout Agent helps remove mud cake and whole mud solids to improve cementing and fracturing operations.



TYPE "HM" RETRIEVABLE PACKER

SPECIAL TOOLS SERVICES

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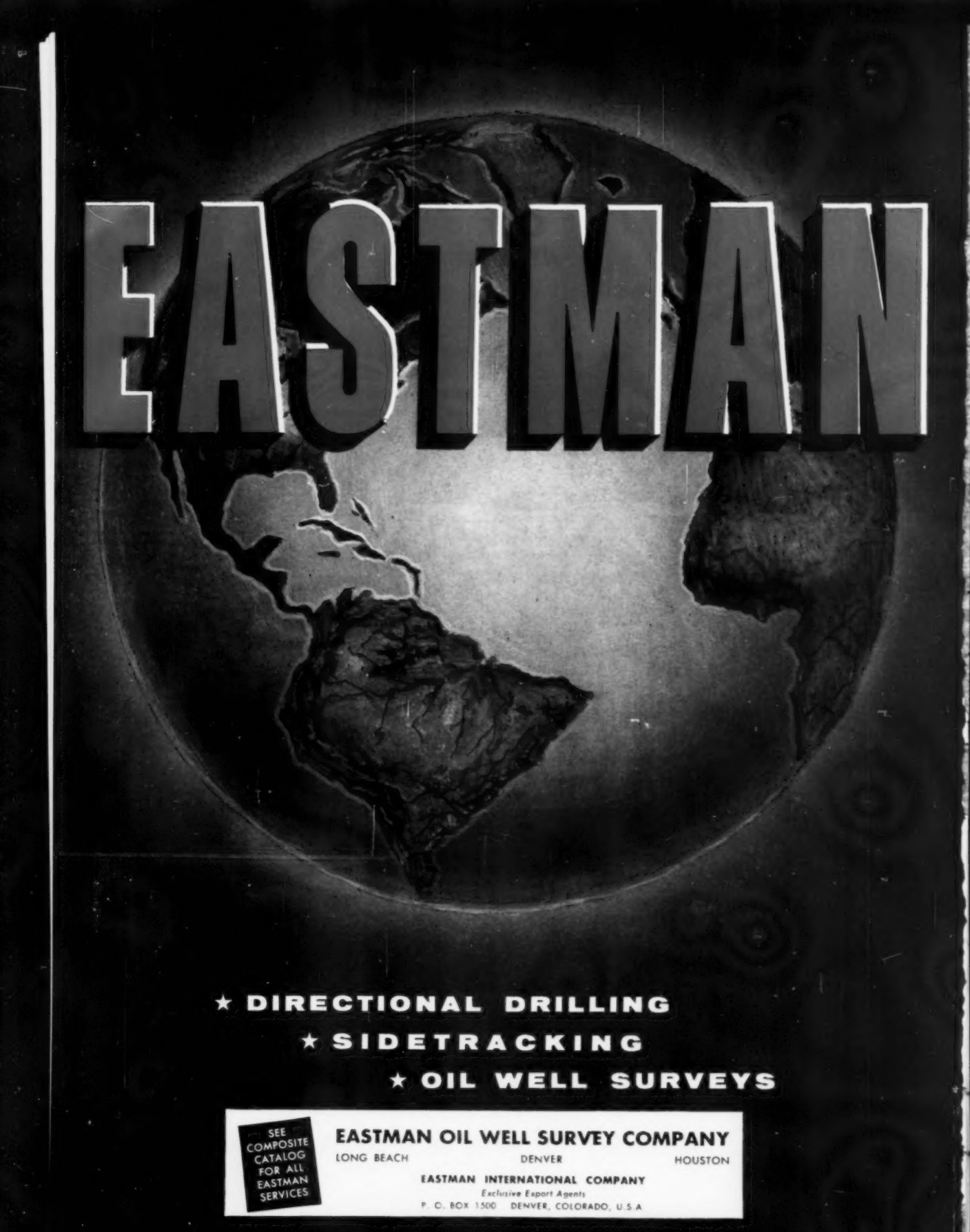

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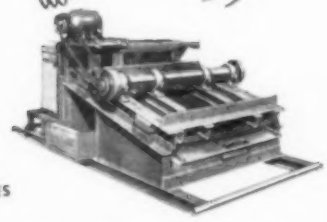

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HOME OF THE WEIGHT INDICATOR — LONG BEACH, CALIFORNIA

Du Pont announces... new HIGH viscosity CMC for drilling muds

Now you can control both fluid loss and viscosity in those areas where *low-solids* muds are commonly used—areas like West Texas and New Mexico.

Du Pont's new *HIGH viscosity* CMC is specifically formulated to meet your need for a low-cost mud additive *which increases viscosity of low-solids muds in addition to reducing water loss.*

Now, with two different viscosity grades, Du Pont CMC for drilling muds is more versatile and useful than ever . . . gives you:

1. Broad viscosity control
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7. Versatile application in a variety of muds

If you are working with low-solids muds, you'll want to try this new HIGH viscosity CMC now. Ask your local mud dealer for it, or contact. . .

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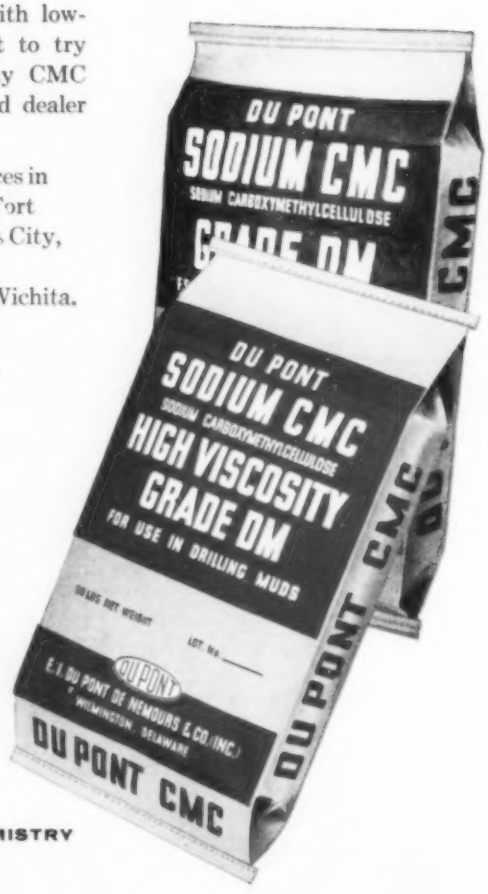
- Macco Corp., Paramount, California.
- Du Pont Explosives Department offices in Dallas, Texas, Los Angeles, California, or Wilmington, Delaware.



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In carrier landings, planes coming in at more than 100 knots are stopped in a split second. This amazing performance is made possible by having each plane hook onto one of several wire ropes stretched across the flight deck. Both plane and rope receive an almost unbelievable shock at the moment of contact. Needless to say, only top-quality wire ropes can be used for this application because . . .

you can't bargain with safety

While your use of wire rope differs from this carrier application, *safety should be just as important to you.* For, although a "bargain" rope may save you money, it can cost you your peace of mind. So don't bargain with safety. Buy a rope that's a *quality* rope—buy Wickwire Rope. 5049

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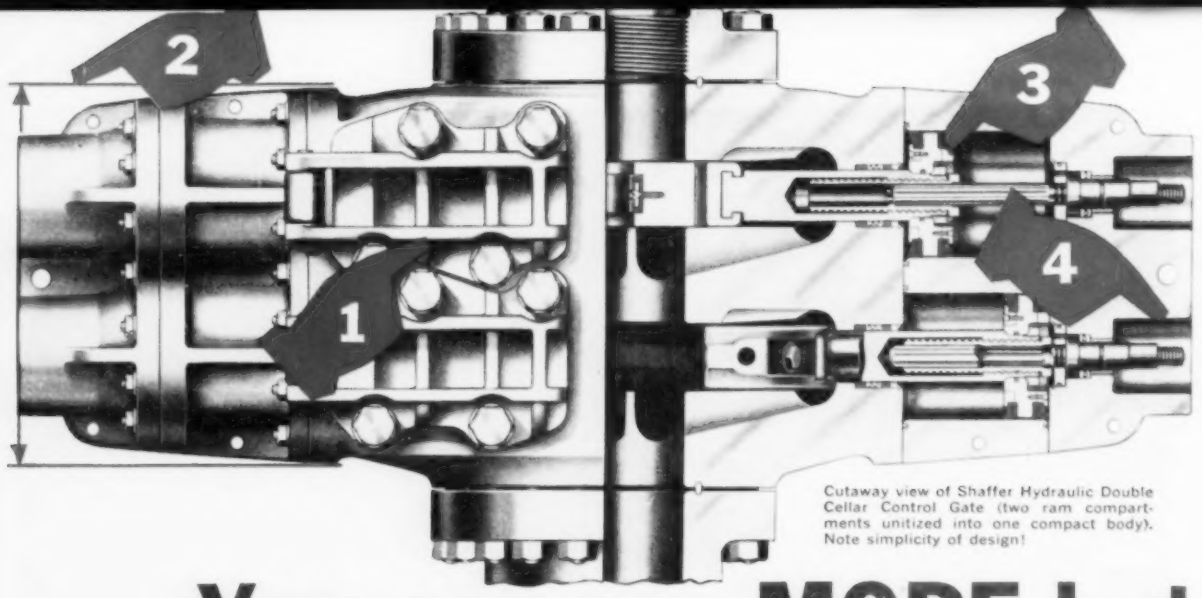


Cutaway view of Shaffer Hydraulic Double Cellar Control Gate (two ram compartments unitized into one compact body). Note simplicity of design!

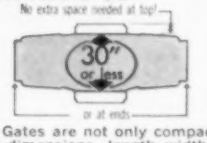
You can pay MORE but you can't buy BETTER than SHAFFER Cellar Control Gates

Before you buy your next cellar control gate equipment, check the field. Note the unique* years-ahead *features built into Shaffer Hydraulic Gates. Compare—and you'll find you can pay* more *for cellar control gates, but you can't buy better than Shaffer!

ADVANTAGE #1

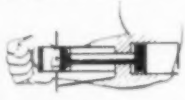
Simply open convenient side doors to change rams—and closing the doors automatically aligns the new rams for proper operation. No extra room is needed above the gate—nor is added space required at the ends—to change rams. Moreover, complete ram changes can be made whether the pipe is in or out of the hole!

ADVANTAGE #2



Shaffer Gates are not only compact in all three dimensions—length, width and height—but there's no need to expand the gates endwise to change rams, nor need extra space be allowed above the gates for lifting out the rams. Even sizes as large as 13⅜" (12" Series 900) are only 18½" high in Single Gates—only 30" high in Double Gates!

ADVANTAGE #3



In Shaffer Gates there are no complicated yokes, no secondary connections between pistons and rams. For maximum safety and simplicity, each ram is operated by a single direct-connected piston!

ADVANTAGE #4

Whether you prefer the extra compactness of a non-rising locking shaft, or the quick indication of ram position afforded by a rising shaft, you choose the design you prefer when you select Shaffer Gates!

In addition, Shaffer Gates have *Self-Draining Compartment Bottoms* (no detrimental sand or mud accumulates to interfere with free ram travel)... *Completely Enclosed Design* (no exposed moving parts to become damaged or corroded)... *Built-In Flow Connections,* and many other unsurpassed features that add up to greater safety, greater dependability, greater convenience. Get the full story from your nearest Shaffer representative—or write direct for further details!

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He's supervising the separation, by Magcobar's original flotation process, of only the highest quality barite from native ore out of the Magnet Cove deposit. The Malvern, Arkansas plant, built in 1939, and still the model of processing plants, has the largest capacity of any single barite plant in the world. Continuous expansion, with modern innovations, keeps this plant operating at greater capacity every year. Other Magcobar barite plants are located at New Orleans, La.; Lake Charles, La.; Brownsville, Texas, and Battle Mountain, Nevada.

The ability to find and process more barite every year to meet the demands of the oil industry has distinguished the Magcobar organization since its inception.

In every Magcobar plant, good men are provided with modern plant facilities to insure you of an adequate supply of the finest quality drilling fluids in the oil fields.

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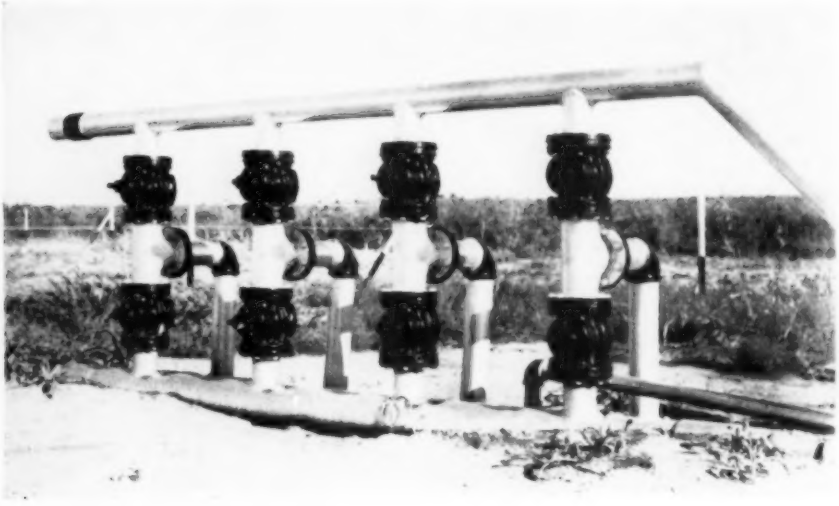
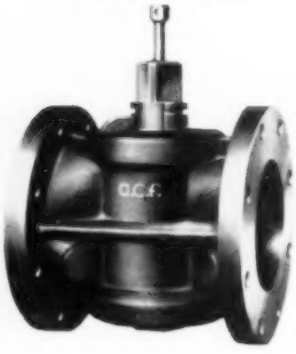


acf LUBRICATED PLUG VALVES



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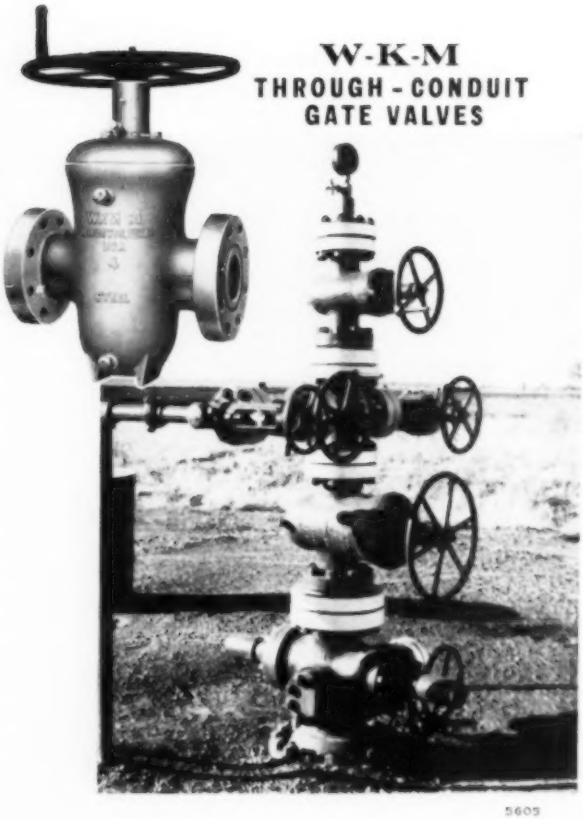
For your Christmas Trees, flow lines, and wherever else high pressures must be safely and positively controlled, there are the famous W-K-M- through-conduit gate valves, in working pressures from 1,000 to 15,000 pounds.

acf lubricated plug valves, of steel, semi-steel, and special metals, with round or rectangular ports, in working pressures from 200 to 500 pounds — are the perfect companion valves for gathering lines, manifolds, headers, and similar low pressure installations.

Because you need the finest in service wherever valves are required, you will be way ahead when you specify W-K-M or acf valves for their respective applications.

W-K-M THROUGH-CONDUIT GATE VALVES



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"What you want — when you want it" means more than a "delivery service" at Wilson Supply Stores. It means the complete cooperation of a skilled personnel with those men who drill the wells and produce the oil.

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HOUSTON, TEXAS

NEW Drilling and Producing Equipment

Liquid Metering Vessel. Development of a new positive volume type liquid metering vessel which registers discharge on a pneumatically-operated counter has been announced. The new Model 26 IM unit has a capacity of 1 bbl per liquid cycle and operates at a working pressure of 150 lb psi. Special models are available

with working pressures ranging up to 1200 psi.

Designed for field use to afford accurate metering of oil and water from either separators or treaters, vessel eliminates the need for liquid level controls or dump valves on vessels to which it is connected. *Oilfield Equipment Division, Delta Tank Manufacturing Co., Inc.*

Circle number (1) on reply card.

Over-Running Clutches. Two new series of sealed, double ball-bearing sprag clutches for over-running, indexing and backstopping purposes are now available. Intended primarily for indexing applications in which the retention of light oil is essential to long life and accurate indexing, they are also specified for situations where abrasives are present in the atmosphere, since the seals prevent contaminating particles from entering the clutch. Over-running and indexing clutches are oil lubricated. Backstopping clutches are grease lubricated. *Application Engineering Department, Formsprag Company.*

Circle number (2) on reply card.

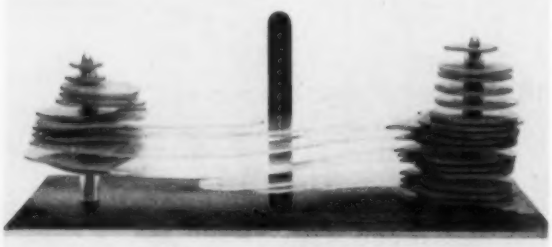
Pipe Coupling Machine. Faster pipe installations are made possible by a pipe coupling machine designed and built by Davis Manufacturing Company. Eliminating chains and tedious assembly, the Davis Pipe Coupling Machine is made in various sizes for installing all types of pressure-type joints 6 through 16 in. diameters. Another important feature of the machine is the simplicity of its operation. The easy-grip handle pushes to uncouple, pulls to couple, without removing or resetting the unit. *Davis Manufacturing Company.*

Circle number (3) on reply card.

Measures LPG Cavities by Sound. New electric-line tool that measures size and shape of underground cavities by converting reflected sound waves into distance is developed. Called Sonar Caliper, new tool is an oilfield adaptation of well known devices used in sonic navigation and ranging. Sonar Caliper was specifically designed to measure brine well cavities, but appears equally useful in determining the capacity of LPG storage reservoirs. A survey with the caliper is made up of a series of horizontal cross-sections of the underground cavity, each one showing the size and shape of the cavity at a given depth. Initial work was done by scientists of The Dow Chemical Company to answer need for an improved method of measuring its brine wells, and final work was done by Dowell engineers.

The caliper works on the pulse-echo idea, timing the rate of travel of sound through a fluid medium. The sound waves produced by the subsurface tool are picked up by a receiver after they have traveled to the cavity wall and back. A timing device records the interval, which is converted into distance. The outside circumference of the cavity is shown on a Polaroid-photo recording unit. Accuracy of the new Sonar Caliper, from both a range and directional standpoint, is estimated at plus or minus 5 percent. Down-hole tool is 50 in. long and 3½ in. in diameter. Its size permits it to be run through 4-in. ID pipe, suspended on a single conductor wire line. It has several advantages over similar tools in that surveys can now be made faster, few advance preparations are necessary, and tool's minimum supersonic beam-angle provides better accuracy. Data is recorded automatically and permanently. Sonic sending and receiving devices in the tool rotate continuously, so that measurements are rapidly made in 360 deg turn at instrument level. Correlation between readings at different levels permits accurate determination of cavity shape and volume. *Dowell Incorporated.*

Circle number (4) on reply card.



Model made from sonic surveys. Correlation of data shows shape of cavity as well as volume.

←Sonar Caliper tool is 50-in. long by 3½-in. Unit contains sending and receiving devices plus sweep rotator.

Perforating Charge. Advanced Oil Tools has developed a new perforating charge which perforates the casing with 1 by 3-in. slots. The charge is of a jet nature and has been test fired under fluid into targets of 4½, 5½ and 7-in. pipe backed with cement. From results of tests it has

been determined the slot charge gives an average depth of penetration of 8 in. and 102.95 cc in volume and 2.356 sq in. in frontal opening area. Gun carrying the charge is of brittle cast aluminum which disintegrates upon firing. *Advance Oil Tools Inc.*

Circle number (5) on reply card.

Sucker-Rod Wiper. Revolutionary new sucker-rod wiper not only wipes rods but acts as a blowout preventer. One size wiper handles all sizes of rods from ⅝ to 1-in. without any changes. Some advantages are that it is safe and dependable for wiping rods clean, including the pump, couplings, rod guides, scrapers, and bottom-hole equipment, and it can be left on

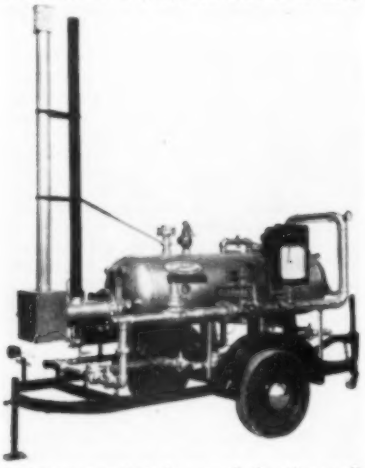
the well as blowout preventer. If rods are out of the hole, wiper can be closed on pony rod, hammer handle, sucker-rod wrench handle, etc. to provide seal. *Gearench Mfg. Company.*

Circle number (6) on reply card.

Safety Panels. New expandable safety panels that automatically shut off engines should oil pressure drop to a dangerously low level or engine water temperatures rise to a dangerously high point have been developed. Available for both battery and magneto type ignitions as well as diesels, these new expandable panels include pre-cut holes for the insertion of a Stewart-Warner tachometer, Hobbs Hour Meter or other instruments or gages as needed in any particular installation to facilitate clocked maintenance or inspection. A drop in lubricating oil pressure or rise in engine temperature is easily and safely detected before costly damage can result to the engine. Protection around-the-clock for expensive equipment, these panels provide the safety of a watchman and detect malfunction automatically. *Instrument Division of Stewart-Warner Corporation.*

Circle number (7) on reply card.

Cold Weather Well Testing. Oil Metering and Processing Equipment Corp. has designed a special heating unit accessory for cold weather use on its well tester. Heating unit has 2 purposes. One is to keep



water, separated from oil in the well tester, from freezing. The second is to separate emulsified water from oil. The latter is accomplished by warming the oil until it allows the water to coalesce. *Oil Metering and Processing Equipment Corp.*

Circle number (8) on reply card.

Spherical Metering Separator. Sivalls Tanks, Inc. introduced a spherical metering separator for well test and other purposes. It consists of a 41-in. outside diameter spherical oil and gas separator and a dump type positive displacement meter, with a new controls system designed to obtain high accuracy. This metering separator offers a number of distinct advantages, including compactness — overall height only 78 in. — and high capacity. It is rated at 6,000,000 cu ft of gas and 1500 bbl of well fluids per day. All parts used in this new metering spherical separator are stock items, and service and parts are readily available. *Sivalls Tanks, Inc.*

Circle number (9) on reply card.

Digital Data Control Systems. Electro-Span is a new digital data transmission and control concept used for highly accurate measurement, control and indication of numerous industrial operations. All systems will perform on commonly used communications channels — telegraph circuits, telephone lines, VHF radio or microwave links.

One of the most common examples of liquid level gaging is found in petroleum tank farms. Electro-Span tank gaging system provides a visual gage at tankside, transmission of data to a central location, and record of information by lamp indicator, automatic electric typewriter, punched card, punched tape, or graphic chart. It will automatically show sequential readout of a number of tanks or of a single tank as well as average temperature of tank contents.

Electro-Span used for pipelines transporting oil, fuel and gas provides for flow, pressure, temperature and malfunction warning with supervisory control. *Bendix Aviation Corporation.*

Circle number (10) on reply card.

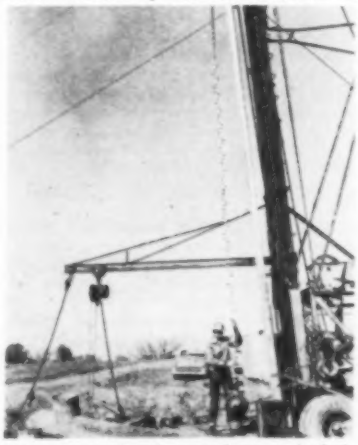
Improved Logging Tool. Development of a new, smaller, more stable source of neutrons for neutron logging has been announced by Well Surveys, Inc. New source, made from actinium, emits a high neutron flux with a relatively small emission of gamma rays. This feature, together with the stability of the source as a result of its relatively long half-life, produces an improved neutron log with a minimum of erroneous indications. The first actual neutron source utilizing actinium mixed with beryllium has been in field use for over a year during which it has repeatedly demonstrated the anticipated advantages of stability and safety. *Well Surveys, Inc.*

Circle number (11) on reply card.

Compact Well Servicing Pump. Newly designed triplex plunger pump makes cementing, acidizing and fracturing operations more efficient and economical. This pump is available with an underslung jackshaft, which brings the jackshaft in closer connection with the power take-off provided by the truck. As a result, power transmission is more direct. New Gardner-Denver 8-in. stroke pump is rated at 310 bhp for this service. With 4½-in. plungers, it develops 290 gpm at 1550 psi to 56 gpm at 8000 psi. With 4-in. plungers, the capacity ranges from 228 gpm at 2000 psi to 44 gpm at 10,000 psi. *Gardner-Denver Company.*

Circle number (12) on reply card.

Perforating Equipment. Selecto-Jets, expendable perforators of well casing for combined use with a gamma-ray probe, are announced by Birdwell. Features of



the new perforating equipment include better penetration and less burr in the casing because of larger charges, more favorable positioning of charges, and a minimum of debris left in the well. Selecto-Jets pressure-sealed aluminum cases are fastened rigidly on a single 5/16-in. aluminum tube of any length up to 50 ft or more in which there is a primer cord. *Birdwell Inc.*

Circle number (13) on reply card.

Diesel Engine. Latest Waukesha supercharged engine model, the 197-DLCS, is a compact and powerful heavy-duty, 6-cylinder, 4-cycle, full diesel engine of 302 cu in. displacement. Supercharged diesel offers lively acceleration, clean burning, prompt starting, a tremendous reserve of power, and greater over-all economy. Without an intercooler the maximum power available from the Model 197-DLCS Turbi-Diesel is 131 hp at 2800 rpm. Without positive drive from the engine, the parasitic load decreases at part engine load, which improves over-all fuel economy throughout the speed range. *Waukesha Motor Company.*

Circle number (14) on reply card.

Doubles Well Service Unit. Skytop Rig is now producing the Welter Weight well service unit. It is a doubles rig with a 65 ft mast capable of racking pipe in doubles. Open crown and traveling block de-

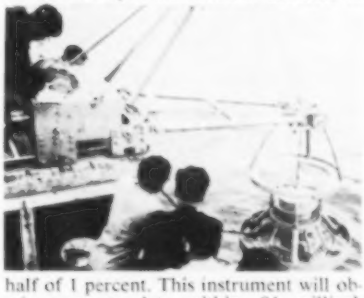
sign permits racking tubing above the traveling block. Rig features light weight and mobility. The Skytop Welter Weight can service wells to 10,000 ft and is powered by a Hall-Scot Model 590 engine. *Skytop Rig Company.*

Circle number (15) on reply card.

5000 Watt D-C Electric Plant. A new lightweight, portable 5000 watt d-c electric generating plant is being made available. This completely self-contained generating plant will provide full capacity electric power to operate lights, electric tools and universal motors for contractors, and for manufacturers whose equipment necessitates the use of d-c power. Prime mover for plant is the Onan 2-cylinder opposed, 4-cycle, air-cooled, gasoline engine, Model CCK. This engine is rated at 12.9 hp; is specifically designed for smooth running, heavy-duty, economical electric plant operation. All-climate generator is directly connected to the engine for positive, permanent alignment. Rated at 5000 watts, 115 v direct-current, its total weight is 315 lb. *D. W. Onan & Sons Inc.*

Circle number (16) on reply card.

Marine Gravity Meter. Model UW-2R Marine Gravity Meter, a remote reading, self-leveling underwater instrument submersible to 800 ft of water, has been introduced. Depth indication is accurate to



half of 1 percent. This instrument will obtain accurate data within .01 milligal *North American Geophysical Company*

Circle number (17) on reply card.

NEW Literature

For more information on items described here in brief, use the handy reply card and circle the corresponding numbers

Template Permits Scale Drawing. Minnesota Rubber & Gasket Company has issued a template-ruler that permits faster and more accurate drawings of the firm's Quad Ring seal. The ruler will be given to all design engineers whose companies are now using or intend to utilize the new four-lipped ring in various sealing applications. Five available cross sections are cut out of clear styrene plastic to true size and contour. The company issued the template-ruler because of the Quad Ring seal's unusual cross section, which was difficult to draw to correct scale and shape in designing components. *Minnesota Rubber & Gasket Company.*

Circle number (18) on reply card.

Two-Way Radio. General Electric's communication products department has published 2 bulletins on two-way radio selective-calling. ECR-448 describes "Individual Call," which enables an operator to turn down radio volume until he receives a light or buzzer signal indicating an incoming call. ECR-439 explains "Group Call," showing how a radio-equipped fleet may be sub-divided into as many as 10 different groups according to job functions, by types of vehicles, or by locations served. *General Electric Company, Communication Products Department.*

Circle number (19) on reply card.

Wire Line Specialty Tools. A 24-page brochure covering wire line specialty tools for permanent well completions and related well servicing operations is available. Cutaway drawings, engineering data, parts and price lists, and recommended use, as well as operation and maintenance, are given. The equipment shown in the brochure makes it possible for the production or service company operator to obtain a complete wellhead assembly as a unit installation engineered to his specific operating requirements. *Bowen-ITCO.*

Circle number (20) on reply card.

Electrodes. "Rexarc Engineered Toughness" is the title of a 20-page manual on Rexarc hard-facing and manganese electrodes. A comprehensive procedure section artistically illustrates many typical buildup and hard-facing applications for better wear resistance. Recommended application procedures are shown, together with the type and quantity of material required, and the range of machine settings for each. In addition, an elaborate Directory of Uses, by industries, features an alphabetical list of worn parts that can be rebuilt, and names the proper electrode for the purpose. The manual presents many aids to the welder. *The Sight Feed Generator Company.*

Circle number (21) on reply card.

Single Drum Multi-Purpose Portable Hoists. A new 12-page, 2-color booklet, No. 3-83, describing Joy single drum multi-purpose portable hoists has been published. The booklet carries descriptions and specifications for the Joy line of air, electric and gasoline driven models. Ranging in size from 0.9 to 15 hp, the hoists have lifting capacities from 750 to 5000 lb at rope speeds up to 125 ft per min. Wire rope capacities range from 200 to 1500 ft. *Joy Manufacturing Company.*

Circle number (22) on reply card.

Colfoam Microballoon Spheres. Colton technical Bulletin MB-110 contains instructions for the use of Colfoam Microballoon Spheres on tanks with mixers. A representative table for an intermittent mixing cycle where the mixer is operated during both the filling and emptying cycles is included in this bulletin. *Colton Chemical Co.*

Circle number (23) on reply card.

Two-Channel Galvanometer Recorder. Specifications and features of the new Dual recti/riter, first 2-channel rectilinear galvanometer recorder, are contained in a 6-page, 2-color bulletin. It records 2 functions rectilinearly on 2 full 4½-in. scales on a single chart, and is availab'e with a 10-speed fingertip-controlled transmission. *Texas Instruments Incorporated, Industrial Instrumentation Division.*

Circle number (24) on reply card.

Balanced Valve Regulator Bulletin. A newly revised 12-page photo-illustrated bulletin (No. 1082, Rev. 2) describing Rockwell's 014 low-pressure balanced valve regulators has been issued. Outstanding new features of the revised version include a detailed schematic drawing illustrating use of the Rockwell 173 high-pressure regulator for pilot-loading of the 014 and a similar drawing showing use of the Rockwell Type 39 power pilot regulator for the same purpose, with the help of a new adapter which facilitates mounting. *Meter and Valve Division, Rockwell Manufacturing Company.*

Circle number (25) on reply card.

Longer V-Belt Life. Simple precautions to prolong the life of V-belts, increase drive efficiency and thereby assure full continuous production are contained in a new 12-page bulletin.

It describes various types of V-belts and tells how to select and match them. It lists 7 steps for the correct installation of belts and offers as many hints for making them last longer. Portrayed are 8 most common causes of V-belt destruction. These include snub break, slip burn, base cracking, abrasion, oil deterioration, rupture, ply separation, and worn sides. *Allis-Chalmers Manufacturing Company.*

Circle number (26) on reply card.

Handy Catalog-Packet. Mobile Drilling has combined all its descriptive literature in a handy catalog-packet. The main body of the catalog is devoted to Mobile's extensive line of earth drilling accessories including augers, core barrels, drilling heads and bits, winches, couplings and other equipment. Pockets on the inside front and back covers carry additional literature on the company's complete line of mobile rotary drilling rigs. *Mobile Drilling, Incorporated.*

Circle number (27) on reply card.

Fuel Injection System. A 12-page booklet, "Cummins PT Fuel Injection System," has been released. Printed in 4 colors, it shows cutaway views of the 4 PT fuel pump assemblies as well as the PT injector. A section is also devoted to optional governor arrangements. *Cummins Engine Company, Inc.*

Circle number (28) on reply card.

Slush Pump Maintenance. The "Slush Pump Maintenance Manual," a 60-page publication designed to improve maintenance, handling and replacement practices with regard to fluid end pump parts, has been published. This very complete and comprehensive work is devoted principally to the consideration of fluid end pump parts but also takes up the pressure side of the hydraulic system, surface mud system, suction conditions and selection of drilling fluids. Other topics are the importance of piston-liner clearance, location of troubles that cause knocking, typical fluid end pump parts troubles and possible causes, table of pump capacities, measurement of rods and liners for ordering. *Mission Manufacturing Company.*

Circle number (29) on reply card.

Metalweld Offers Booklet. A comprehensive report on protective linings and coatings is now available.

This brochure discusses types of protective linings and coatings, why they are important, when and how they should be applied. Its section on porosity explains what it is, how it can be determined, and what to do about it. Suitability of a protective system to its environment is also discussed in detail. *Protective Coatings Division of Metalweld, Inc.*

Circle number (30) on reply card.

Portable Filtreat Unit. A bulletin introducing the first complete portable filtration and treatment unit designed expressly for oilfield service has been published. The Atlas Filtreat Unit is compactly packaged for transportation on a portable skid, and all electrical controls and instruments are panel mounted. Bulletin also lists the features of the unit and shows a schematic flow diagram of typical filtreat water treatment and filtration installation. *Atlas Associates, Inc.*

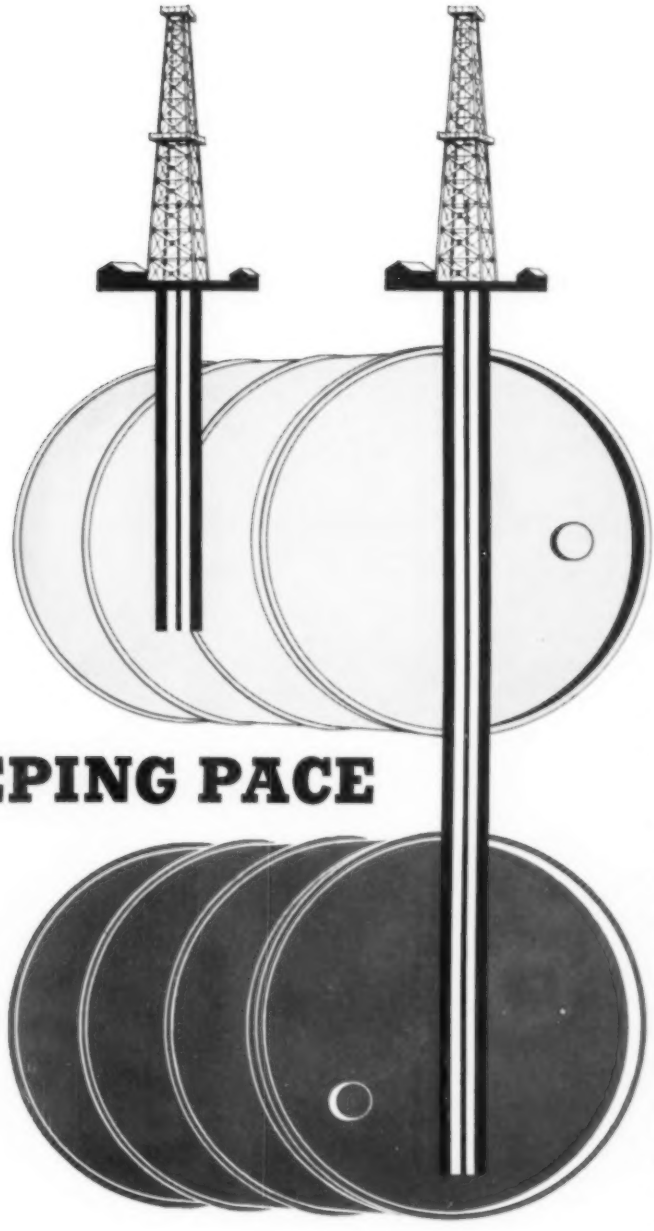
Circle number (31) on reply card.

"Products and Processes." A new bulletin, entitled "Products and Processes," comprising 32 pages, fully illustrated, dealing with all water and waste treatment equipment designed and manufactured by the company, has just been released by Infilco Inc. It contains cross-references for all detailed bulletins devoted to specific equipment in municipal, industrial, sewage and industrial waste treatment fields. *Infilco Inc.*

Circle number (32) on reply card.

Opportunities as a Technician. A 32-page educational aid booklet entitled "Your Opportunities in Industry as a Technician" has been published. It emphasizes the vital role and promising futures in this comparatively new and growing occupation. Citing the enormous range of activities and career opportunities in all fields, the pamphlet notes that the technician holds a key spot between the engineer and craftsman in industry, between theory and production. An average of between 5 and 7 of these specialists are reported needed right now for every one professional engineer in all areas of industrial research, development and production. *The Education Department of The National Association of Manufacturers.*

Circle number (33) on reply card.



KEEPING PACE

Drills were chewing their way down for about 2000 feet in the search for oil in 1916. Today's drilling depth is more than double that.

The change in drilling that forty years has brought well symbolizes many advances in the petroleum and chemical industries. Engineers have dug more deeply into the secrets of nature, too . . . have designed plants and processes to wrest new products and services from petroleum, ores and elements.

We mentioned 1916 because that is the year Sun Ship was founded. It has long served the swift-growing needs of petroleum and chemical industries. Year by year, the engineering skill and facilities of the great Sun Ship plant have proven their ability to meet the demands for plant and equipment keyed to the swift pace of progress in these and other important fields. Sun Ship keeps pace with progress.

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Producers of: Catalysts, Inorganic Acids, Superphosphates, Triple Superphosphates, Phosphate Rock, Silica Gels and Silicofluorides. Sole Producers of DAVCO® Granulated Fertilizers.

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

New Projects in refining gas processing petrochemicals

B. F. Goodrich Chemical Company plans a $5-million plant near Henry, Illinois, for production of chemicals such as antioxidants for the petroleum, rubber, and plastics industries. Scheduled for completion in early 1958, the plant will be built by Blaw-Knox.

Atlantic Refining Company will build a 2100 BPD alkylation unit at its Port Arthur, Texas, refinery to produce high-octane component for premium gasoline. Start-up is planned for spring, 1958.

Imperial Oil Company, Ltd. has received clearance from city officials to proceed with a $17-million project that will triple capacity at its Calgary, Alberta, refinery.

Richfield Oil Company, entering into petrochemicals, will build a 16-million gal per yr benzene unit at its Watson, California, refinery. Plans to be in production by mid-1958. Immediate plans for a phthalic plant are shelved, but studies on it are continuing.

Standard Oil Company (Ohio) has scheduled a 3750 BPD sulfuric acid alkylation unit for construction at its Cleveland No. 1 refinery. The $3.4-million unit will go onstream in May 1958, will be built by Arthur G. McKee & Company.

Cit-Con Oil Corporation will spend about $4-million to expand paraffin wax production by 25 percent and light oil production by 20 percent at the Lake Charles, Louisiana, plant. Project includes expansion of a cooling tower, and vacuum distillation, furfural extraction, and MEK dewaxing units.

Standard Oil Company of California plans to build catalytic reforming units at its Richmond and Bakersfield refineries. Both units will be onstream in mid-1958.

Standard-Vacuum Refining Company is spending $9-million to expand its Durban, South Africa, refinery from 20,000 to 25,000 BPD. New units will include a Powerformer and a distillate Hydrofiner to be built by Foster Wheeler Corporation.

Tennessee Gas Transmission Company will recover about 43,000 gal per day of natural gasoline and gas liquids in a 10 MMcf per day gas processing plant to be built near Lovington, New Mexico. The plant will start operations at the turn of the year.

Shell Oil Company will have Fluor Corporation build a 2400 BPD sulfuric acid alkylation unit at the Anacortes, Washington, refinery. The unit will be completed next year.

Carbide & Carbon Chemicals Company will double acrylonitrile production at Institute, West Virginia, in 1958, due to increasing demand for acrylic fibers, Buna-N rubber, and high-impact resins.

Amoco Chemicals Company will build its $10-million xylene-based chemicals plant near Joliet, Illinois. Mixed xylenes from Standard of Indiana's Whiting refinery will be oxidized to their corresponding phthalic acids; capacity will be about 60,-million lb per year.

British American Oil Company has awarded construction contracts to Canadian Kellogg for a 20,000 BPD refinery to be erected near Vancouver, British Columbia. To be operating in late 1958, principal units include catalytic cracking, catalytic reforming, and alkylation.

Continental Oil Company will add a 3500 BPD catalytic reformer to its 9500 BPD Wichita Falls refinery, at a cost of $1.5 million. The unit is scheduled to go onstream in early 1958.

Shell Oil Company of Canada will make EPON® resins in a $1-million plant to be built alongside its present Montreal East chemical plant.

Cal-Mex Oil & Refining Company is considering several sites near San Diego, California, area for construction of a 20,000 BPD refinery to process foreign crude. Ralph M. Parsons Company will handle the entire $27-million project, which calls for initial operations in early 1959.

Phillips Petroleum Company has contracted Fluor Corporation to build a 16,000 BPD catalytic reformer at the Sweeny, Texas, refinery, with completion set for next January.

Esso Standard S.A.F. will process 1.5 million tons annually of crude from the nearby Parentis field in a refinery to be built at Ambes (Gironde), France.

Socony Mobil Oil Company has purchased a site near Princeton, New Jersey, for a research center to be used for studies on applications of radiation in petroleum technology. Facilities will include a two-million electron-volt Van de Graaff accelerator and a "hot" lab for manipulation of radioisotopes such as Cobalt-60.

Jefferson Lake Sulfur Company will recover 350 tons daily of sulfur from sour gas in a plant to be built in the Calgary, Alberta, area. The gas yields 12 long tons of sulfur per MMcf, will be supplied by Mobil Oil Company of Canada.

Esso Standard Oil Company will soon have a $1-million salt dome storage project in use near Sorrento, Louisiana, 35 miles south of its Baton Rouge refinery. Five cavities will store ethylene, propylene, propane, and butane to offset production and consumption cycles. The picture shows part of the 100-acre tract leased by Esso in the middle of a dense second growth cypress swamp. The salt dome formation is more than 2000 ft below the swamp.

Partial Shroud Impellers Reduce Risk to Bearing Failure at Near Shut-Off Conditions

How to Reduce Pump Thrust Bearing Loads

Chester McFarland
De Laval Steam Turbine Company
Trenton, New Jersey

Fig. 1. Single suction impellers with some of the rear shroud removed.

CONSISTENT results obtained from tests of partial shrouds on process pumps have revealed that thrust loads can be cut approximately 35 percent for operating conditions at or near shut-off. This reduction of thrust load reduces in turn the possibility of thrust bearing failure when operation near the shut-off condition is frequent or continuous.

Process pumps particularly may experience this method of operation. Many processes in petrochemical plants, particularly in the field of polymers and resins, are essentially batch operations. Many times the batches are run close enough together that a desirable "continuous" operation is approached. For the convenience of the operators, pumps used with such a system are often allowed to run at shut-off between batches. Also, pumps in refineries are often run at well under design flow rates, with near shut-off operation being continuous.

An accumulation of safety factors in selecting the intended operating point can also result in operation close to shut-off when the pump is actually installed. Since most process fluids have not been tested for friction flow characteristics as thoroughly as has water, calculations of friction loss are not as accurate as those for water. Coupled with this, future growth in demand is usually considered in selecting the design point.

When a pump is first laid out on the designer's board, he has preselected some commonly desired design point and has calculated the throat, eye and nozzle areas, the impeller vane width and the tip width, etc., all in accord with this preselected design point. Shaft strength and bearings are based primarily on this design point with suitable safety factors for infrequent operation at shut-off.

Effects of operating above and below design point . . .

In the actual application of the developed pump, deviation from this design point is allowed provided the deviation is not too great. An operating point far beyond the design point will force too much volume through the pre-determined areas resulting in higher than desirable velocities. This creates noise and cavitation. On the other hand, operation at reduced capacity at or near shut-off pressure creates additional axial and radial thrust loads, both being functions of pressure and projected areas upon which the pressure acts.

These loads are present throughout the range of the pump but are exaggerated at reduced capacity. There are several methods by which the designer can offset or reduce these forces or their efforts. The volute translates the fluid's velocity imparted by the impeller into pressure energy, the pressure gradually increasing from the "cut-water" or tongue around the volute to the throat through which the fluid escapes. The unbalanced pressures constitute a force in a radial direction causing shaft deflection. Mounting the impeller between bearings and increasing the shaft diameter will give greater shaft stiffness to resist deflection. A double volute

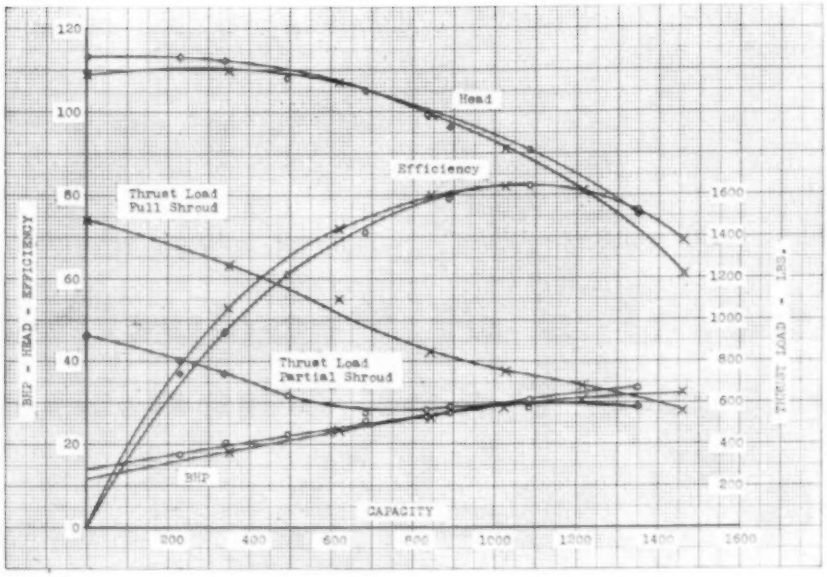
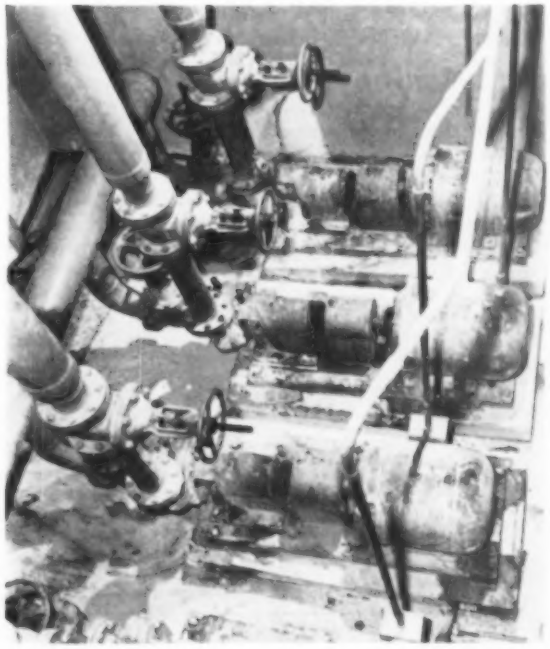


Fig. 2. Operating characteristics of similar pumps, one equipped with a full shroud impeller, the other with a partial shroud impeller. Note the difference in thrust load at low capacity, near shut-off conditions.

Fig. 3. Partial removal of the impeller shroud cut operating expenses and practically eliminated downtime on these pumps.



design can be obtained by locating a second tongue 180° around the volute from the first providing balanced pressures.

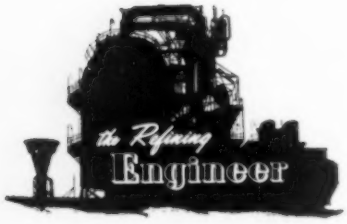
Thrust in the axial direction arises from an unbalance of discharge pressure acting in one direction against suction pressure acting in the other. A double suction impeller with its inherent hydraulic balance at all points is used in horizontally split case pumps and will overcome axial thrust for the most part. What thrust then remains is the result of uneven entry of the fluid into the two sides of the impeller because of poor piping arrangement or nozzle casting variation.

What happens when shroud area is reduced . . .

With an end suction overhung impeller design of pump, the shaft can also be made heavier. This design requires a single suction impeller unbalanced axial thrust is present — in a direction toward the lower pressure suction side of the impeller. Remembering that thrust force is essentially some pressure multiplied by the area upon which it acts, some of the force can be eliminated by eliminating some of the area. (The shut-off pressure itself cannot be diminished without changing the design point pressure or altering the shape of the pump's characteristic curve.) Fig. 1 illustrates the single suction open type of impeller with some of the rear shroud area removed.

Fig. 2 reveals the effects of this partial removal of shroud area. This test, duplicated on several single suction overhung process pump designs, establishes the degree of improvement to be expected. In each size tested, axial thrust at shut-off was reduced to approximately 65 percent of the former designer's velocities and volumes are more nearly those originally planned. The partial shrouds do not as drastically affect the thrust load which now approaches the value that would be obtained with full shrouds.

The partial removal of the shroud gives slightly less guidance to the fluid as it leaves the impeller. The efficiency at reduced capacities is lowered slightly. However, process pumps are usually of low power ratings, and the difference in efficiency is negligible, particularly when compared with the increased reliability and adaptability to process applications. ★ ★ ★



Forecasts call for 101-octane pool gasoline by 1965 and 107-octane premium gasoline may be in wide demand. Most economical route to this high-quality fuel appears to be alkylation and isomerization, followed by extraction of catalytic reformates.

Economics of Producing High Octane Pool Gasoline

S. W. Curry *Universal Oil Products Company, Des Plaines, Illinois*

The Refiner's Situation

A refiner in the United States today faces his greatest challenge in the economic manufacture of the high octane motor fuels required by present markets. Since the close of World War II, he has generally been involved in a very fluid manufacturing situation. The quantity demands of the market are increasing very rapidly while the quality requirements are continually taxing the abilities of the operator as well as the processing equipment. Not only have millions of dollars been spent in the last 10 years for increasing refinery throughput, but many more millions have been invested to produce motor fuels of a quality undreamed of prior to World War II.

Nor is the additional investment required for the production of premium motor fuels at an end. Available information indicates that the American public will continue to demand more and more performance from the "highway locomotives" which Detroit is producing in large quantities. Engine designers will in turn achieve this added performance largely by increasing the compression ratio of the engine. This will complete the circle by whetting its appetite for higher and higher octane numbers of the motor fuel it consumes.

We will not discuss the economics of burning higher and higher quality motor fuel in higher and higher performance engines to move in slower and more congested traffic. That subject and its ramifications are alone of sufficient importance to justify several papers. As an observation, however, we can definitely assure the American motorist and the automobile builders in Detroit that this higher quality motor fuel does cost appreciably more to produce than its lower octane number predecessors.

It's expected that the total pool gasoline Research octane number, which averaged 92.2 CFRR in 1956, will reach 100 CFRR by 1964. As shown in Fig. 1, we expect that octane number will advance rather steadily in the foreseeable future at a rate approaching the 1.2 octane number increase experienced annually during the past few years.

Presented at the 45th Annual Meeting of the Western Petroleum Refiners Association, San Antonio, Texas, March 25-27, 1957.

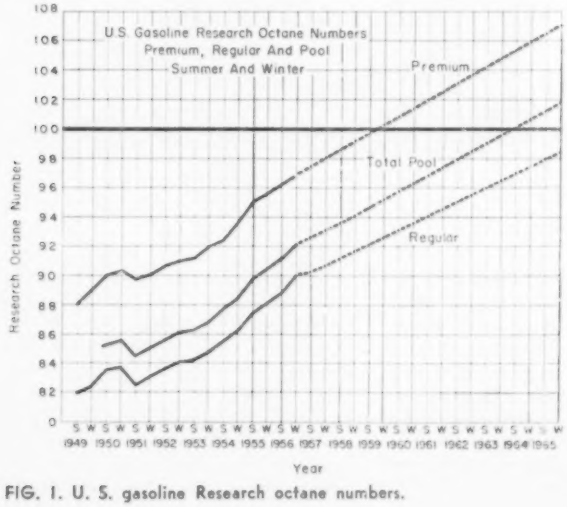


FIG. 1. U. S. gasoline Research octane numbers.

Base Case for Determining Cost of "Octanes"

To demonstrate the approximate magnitude of cost changes as the gasoline pool octane is increased, we have assumed a hypothetical 20,000 bbl per std day refinery operating on a moderately good Illinois Basin crude with the typical analysis shown below.

FIG. 2. Crude charge analysis.

Gravity, API at 60 F.	36.8
Specific Gravity at 60 F.	0.8408
Total Sulfur, %	0.24
Reid Vapor Pressure, lb	5.8
ASTM Distillation	
IBP F.	126
10%	222
30	384
50	558
70	704
90	744
EP, F.	760+
% Recovered	96.5

This imaginary refinery includes all off-battery limits facilities and includes the following process units:

1. Crude Distillation,
2. Vacuum Distillation,
3. Fluid Catalytic Cracking,
4. Gas Recovery,
5. Catalytic Polymerization,
6. Unifining,
7. Platforming.

Because of our familiarity with them, I have taken the liberty of using the applicable processes that have been developed by Universal Oil Products Company. On the base case we will superimpose other processes such as HF Alkylation, Rexforming, and "Penex" Isomerization, showing the effects of each upon pool octane along with the additional manu-

FIG. 3. Base case gasoline pool.

	B/SD	Vol %	API	RVP	F-1 Cl	F-1 + 3 cc
FCC 425 F E P Gasoline	3670	38.1	56.0	5.5	92.5	99.0
2 lb Polymer	610	6.3	60.5	2.0	96.2	99.8
Light S R Gasoline	1400	14.5	82.0	18.5	77.0	92.0
Platformate	3625	37.6	49.5	5.6	85.4	95.8
Butanes	331	3.5	115.0	60.0	100.0	110.0
Total Gasoline Pool	9636	100.0	57.9	10.0	88.1	97.2

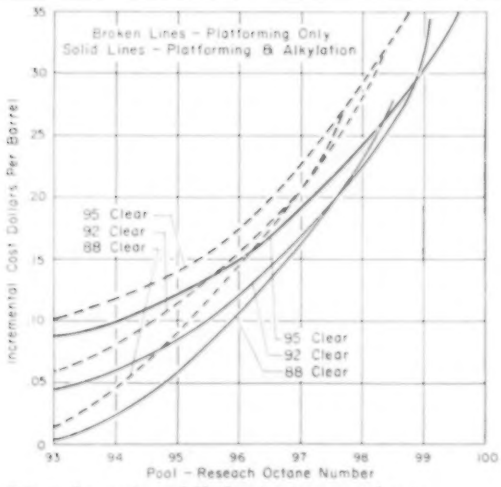


FIG. 4. Comparison of Platforming incremental costs.

facturing and investment costs, and the economics of producing higher gasoline pool octane levels.*

The base case refinery is capable of producing 93 CFRR pool gasoline, using 0.7 ml of TEL per gal, at a total lead cost of 7.4 cents per bbl. Based on today's prices, this gasoline is worth $5.04 per bbl FOB Gulf or, excluding lead content, $4.96 per bbl. Details of the quantities and qualities of this base case gasoline pool are as follows:

Costs and Means of Increasing Pool Octane up to 100 CFRR

When it is desired to increase the gasoline pool octane rating of the base case refinery from 93 to 94 CFRR by increasing Platforming severity alone, there is an increased cost of 4.6 cents per bbl. However, if we increase Platforming severity and also add C_3-C_4 Alkylation, the incremental cost of raising the octane rating of final pool gasoline is only 2.3 cents per bbl. A comparison of Platforming incremental costs and combined Platforming and Alkylation costs at various levels of reforming severity are shown in Fig. 4, while Fig. 5 shows the desirability of combining Platformate and alkylate with other gasoline components, and increasing TEL dosage, to obtain pool octane numbers of 94 CFRR and above.

Calculations used in developing these curves include normal costs experienced in the Gulf Coast for utilities, labor, maintenance, taxes, insurance, and a 10 percent amortization factor on all incremental capital investments for equipment added. The alkylation unit used in the study is assumed to charge about 43 percent C_3 and 55 percent C_4 olefins, using isobutane as the isoparaffin. Economics of adding alkylation are based on purchasing sufficient outside isobutane, at 9 cents per gal, to balance the available C_3-C_4 olefins. Normal butane adjustments to hold the pool vapor pressure at 10 RVP have been adjusted at 5 cents per gal. Also, any excess production of fuel gas is credited at 12 cents MM Btu's.

We've already shown that the cheapest route to producing 94 CFRR pool gasoline octane is to add alkylation, and all subsequent cases therefore include that process. Of several available choices usable to attain pool octane levels of 95 and 96 CFRR, the most economical procedure is to increase the lead content of the final gasoline. Specifically, the incremental cost of obtaining 95 pool octane number over the base case is 6.0 cents per bbl. Similarly, the cost for 96 octane is 9.7 cents per bbl.

Pool octane ratings higher than 96 CFRR would require the operation of the Platforming unit as progressively increasing severities. To reach 97 octane requires adding Platformate testing 90 CFRR, clear, plus alkylate, to the other pool components. Total incremental cost, including additional TEL, is 15.3 cents per bbl.

A pool octane of 98 CFRR would need Platformate testing 92 Research, clear, alkylate and additional lead. Incremental cost over the base case is 22.4 cents per bbl.

A 95 Research octane clear Platformate, alkylate and lead will be required to reach a pool octane of 99 Research. Incremental cost over the base case is 30.3 cents per bbl.

Best Routes to 100-Plus Octane Ratings

Further economic evaluations, not shown, indicate that the least costly route to 100-plus pool octane ratings is the addition of isomerization.

Adding isomerization of C_5's and C_6's involves the separation of isopentane from the mixture, isomerizing the normal C_5 plus all the C_6's as a mixture in a single reactor, dependenizing the reactor liquid product, and recycling dependanizer overhead to the deisopentanizer. In effect, pentane isomeriza-

*All of the processes considered in this paper are in commercial use with the exception of "Penex" Isomerization. Several Penex units currently are either in the design or construction stages.

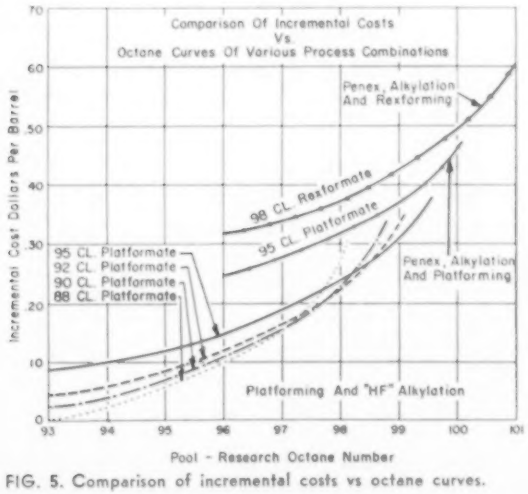


FIG. 5. Comparison of incremental costs vs octane curves.

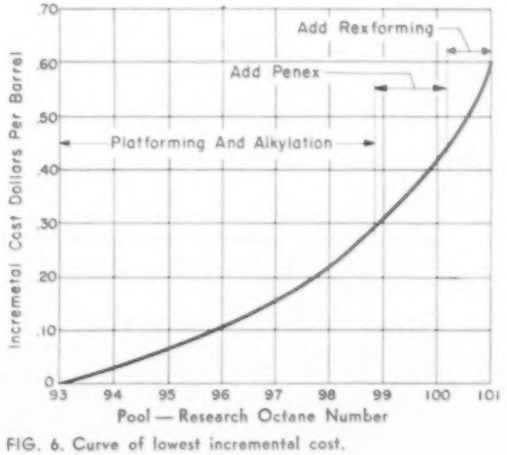


FIG. 6. Curve of lowest incremental cost.

FIG. 7. Final 101-octane gasoline pool.

	B/SD	Vol %	API	RVP	F-1 Cl	F-1+ 3 cc
FCC 425 F E P Gasoline	3670	36.8	56.0	5.5	92.5	99.0
Alkylate	1490	14.9	69.4	2.8	94.0	103.5
Rexformate	3392	34.0	49.8	9.5	98.8	102.8
Isomerate	1029	10.3	87.0	11.5	79.5	95.5
Butanes	403	4.0	115.0	60.0	100.0	110.0
Total Gasoline Pool	9984	100.0	60.3	10.0	93.8	101.0

tion is, therefore, a recycle operation, whereas hexane isomerization is once-through. The product is a combined stream.

The octane rating of the C_5-C_6 isomerate would be 79.5 CFRR clear (95.5 leaded). The Platformer will be operated to make a 95 Research clear Platformate. These, with alkylate and the other gasoline components produced in the refinery, plus TEL, will produce a total pool gasoline rating 100 octane CFRR. Incremental cost over the base case is 45.5 cents per bbl. Without isomerization, Platformate testing 100 Research octane clear would have been necessary and the incremental cost over the base case would have exceeded 50 cents per bbl.

A pool octane rating of 101 CFRR is the highest full octane number readily obtainable under this hypothetical processing scheme. At this level we have reached the anticipated U.S. pool octane required in 1965. Any prognostication concerning pool octane number beyond 1965 would be just that—guesses.

The 101 octane pool gasoline will require all the process units shown for the previous 100 octane case, plus an increase in the severity of the Platforming operation to the level of 98+ Research, clear. At this reforming severity, charging an Illinois Basin naphtha, a Rexformer is indicated as economically preferable to a Platforming operation. We have therefore included Rexforming in this case as a substitute for the Platformer. (In practice the existing Platformer probably would be converted to a Rexformer.) Generally, this would appear to be in order when it becomes necessary to Platform to levels in excess of 95 CFRR octane number, clear. This is not an operational consideration but purely a matter of economics.

Shown on Fig. 6 is the curve of lowest incremental cost for each pool Research octane number and the approximate level at which various processes are added to the refining scheme. The example shown is, as previously noted, for a 20,000 bbl refinery operating on an Illinois Basin type of crude oil. Nevertheless the results would apply with slight modification to the majority of crude oil types and refining schemes. We would particularly emphasize the point that very large refinery throughputs are not required to justify the additional processing equipment necessary to produce super high octane gasoline.

Major components of the 101 octane pool in our hypothetical refinery are Rexformate testing 98.8 Research, clear; alkylate at 94 Research, clear; isomerate at 79.5 Research, clear, plus the other unfinished gasoline streams as shown below. Incremental cost over the base case will be 60.2 cents per bbl.

We believe that we have achieved 101 pool octane by the most economical and direct processing scheme using commercially available processes. There are, of course, several other octane-improving techniques which might be utilized—but at the penalty of economic disadvantage for relatively small octane improvement.

Effects of the Processing Scheme on Yields

Major refining processes historically utilized in the manufacture of high octane gasoline are those which decompose a part of the hydrocarbon feed in the very act of producing the motor fuel. Examples are catalytic cracking and catalytic reforming. There are others, however, that combine gaseous

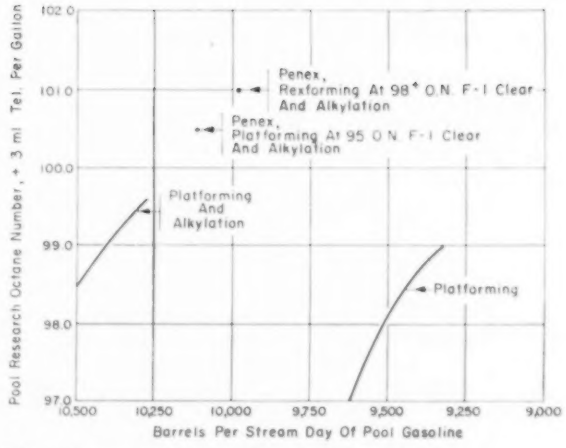


FIG. 8. Process yields for various processing schemes.

hydrocarbons to produce liquids suitable for use in premium gasolines. These include catalytic polymerization and catalytic alkylation. Still others, such as catalytic isomerization, essentially rearrange the hydrocarbon molecule without significant decomposition of the feed stock.

Fig. 8 shows the effect upon yields when producing high octane numbers by various refinery processes which we have considered here. At the present market values for high quality gasolines, any appreciable volume shrinkage is to be viewed with alarm, as it may very well be the highest cost factor to be encountered in octane number improvement. Consequently, the employment of alkylation and isomerization processing, in preference to high severity reforming, is obviously the desirable route from an economic standpoint.

Investment Requirements for Producing High Octane Gasolines

So far we have discussed operating costs but have not stated the capital investment involved in adding HF Alkylation Penex, Isomerization and Rexforming. Fig. 9 shows the estimated incremental capital investment required for process equipment for each additional octane number of the total pool gasoline.

Immediately upon increasing the pool octane number above 93 Research, the HF Alkylation unit previously described and costing about $1,550,000 is indicated. It is capable of producing approximately 1500 bbl per std day of 94.0 Research octane clear alkylate.

Process unit investment cost above the 94 pool octane level is relatively constant up to about 97 octane pool, where it becomes necessary to operate the Platformer at higher severities. Next large investment increase occurs at 100 octane pool, at which time an additional investment of approximately $670,000 is required to install an isomerization unit

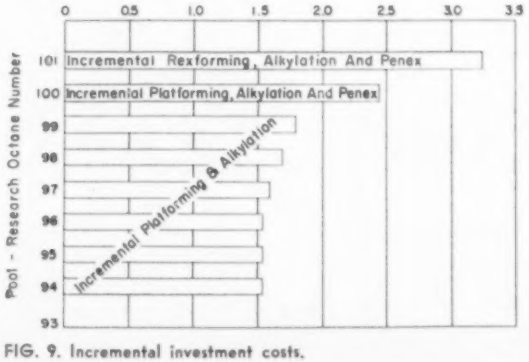


FIG. 9. Incremental investment costs.

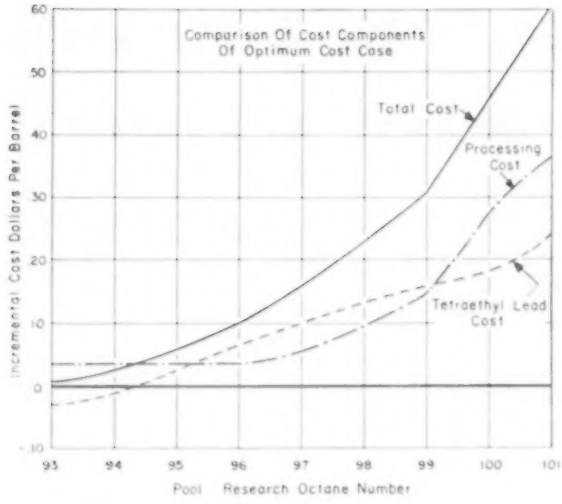


FIG. 10. Comparison of cost components.

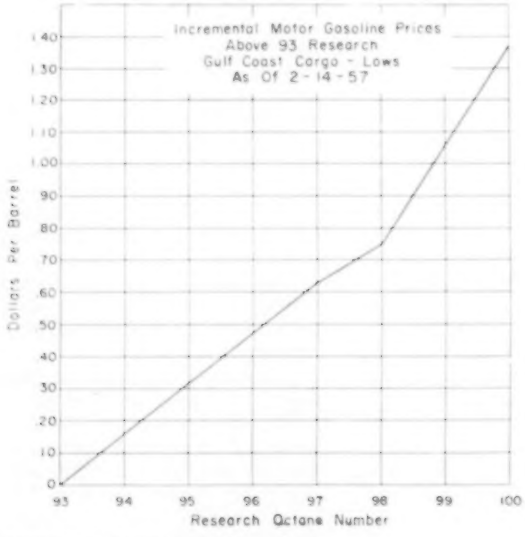


FIG. 11. Incremental motor gasoline prices.

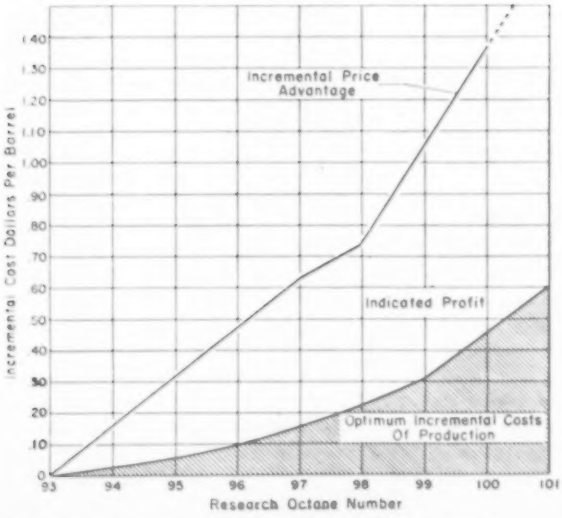


FIG. 12. Profit margins of incremental octane pool quality.

to process approximately 1050 bbl per std day of pentanes and hexanes.

At 101 octane pool it will be necessary to convert the Platformer to a Rexformer, at an investment of approximately $1,000,000. Unit will then be capable of producing 100 octane Research clear Rexformate. As a matter of interest, total amortization cost for incremental investment required at 101 pool octane level, based on a factor of 10 percent per year, amounts to only 12.2 cents per bbl of finished gasoline. Our investigation indicates that other routes which might be employed to achieve this final pool octane number, and further steps which might be utilized to provide very small octane number increases, beyond that indicated, become relatively more expensive—particularly in terms of the capital investment required.

Total incremental manufacturing costs expected in increasing the pool gasoline octane level from 93 to 101 Research is graphically illustrated on Fig. 10 by the solid line. The two major components comprising the solid line are represented by the other two curves. Dashed line indicates the incremental tetraethyl lead costs, while the dotted line shows incremental processing costs.

Profit via Higher Gasoline Octane Numbers

Up to this point, all we have talked about is costs and investments — outgo. By now, you may be thinking: "This is all very interesting, but who is going to pay for it?" Surprisingly enough, based on today's published cargo low prices at the Gulf Coast, there is an attractive profit to be gained at the present time from producing this material.

Fig. 11 illustrates the incremental motor gasoline price advantage for material exceeding 93 Research octane number, indicating that 100 Research octane gasoline is worth $1.365 more at the Gulf today than 93 Research octane gasoline.

Profit margin available to the refiner based on previous cost calculations, vs the present market price, is shown on Fig. 12. Again using the price advantage shown for 100 Research octane gasoline in published quotations, and subtracting from it the incremental cost of production, we find a net advantage of 91 cents per bbl for producing the 100 octane product. Furthermore, we have calculated that our hypothetical refinery will produce about 10,100 bbl per std day of 100 octane pool gasoline. By altering his processing scheme to permit the production of 100 octane pool, our refiner could improve his profit position today by approximately $9,200 per stream day, or some $3,200,000 annually. That, quite simply, is how the equipment is paid for — and in just about 12 months.

Timing Is Important

A further point which should now be considered is the time interval involved between the inception of the idea for, and the completion of, the project based on normal refinery construction standards. It usually ranges from 18 to 24 months. Effectively, this means we must anticipate our processing problems by at least that range of time. As you know, it is more economical to operate a refinery at the conditions and throughputs for which its elements were designed instead of suffering the unfavorable cost and processing headaches attendant with operating an inadequate processing scheme under "crash program" circumstances which might be required to meet competition.

We are firmly convinced that confident and timely planning, based on proper economic evaluation, will repay many times the effort expended. In the past many of us have been operating with a sort of "billiard ball" motivation. Something happened which caused us to react in a particular way and this in turn caused something else to happen, etc. In face of the present flexible situation and high manufacturing costs, it is believed that the only houses which will remain standing over the long run will be those of the wise little pigs who planned carefully and built strongly. ★ ★ ★

ASPHALT is coming into its Own—In a Hurry

Asphalt, classically defined as "a brown to black cementious material occuring in nature or obtained from the refining of petroleum," has long been misunderstood by management, with the obvious result that its potential as a profit-maker has not been completely exploited. Now, thanks to the well publicized $100 billion nation-wide building program, all levels of management and technology in asphalt manufacture and sales are beginning to take a closer look at some of the headaches that have plagued and perhaps retarded the industry for years, and are looking at how to make the most of the future.

Refiners are gleeful about the effects that the road-building program has had on the sales of petroleum products. Asphalt sales are climbing rapidly, are expected to reach 130 to 150 million bbl per year by 1960-1967 — up about 50 percent from the consumption of 92,000,000 bbl in 1955. But that is just one part of the picture: Vast new markets for petroleum products are visualized, products to build and operate road-building machinery, fuel to power the cars that we use on the highway network, and lubricants to keep the wheels turning smoothly. For example, some expected demand for motor fuel to double, perhaps even triple by 1970. We will have 90 to 100 million vehicles on the highways by then, whereas we have only 65 million vehicles now operating.

For twice as many vehicles to travel twice as many miles as this year's cars, we must have more road and more parking space. Average annual mileage per car has been dropping slightly these past few days and will doubtlessly continue to drop until the highway program is well on its way to completion. The 25 to 35 million additional cars that will be on the roads by 1970 must have 85,000 miles of singlelane highway just for them to be bumper to bumper. Much more mileage of highway is needed to drive normally.

In all this sunshine there are some sobering thoughts, however. Somebody has to pay for the construction program through the form of taxes — taxes on petroleum products. It is the duty and responsibility of the petroleum industry to see that the tax dollars are used efficiently, and asphalt spokesmen believe that their product is an important key to get the most mileage out of the tax dollar. And the refiner would like to make a profit, too.

These and many other problems facing the asphalt manufacturer were brought out in an Asphalt Symposium held at the Western Petroleum Refiners Association's forty-fifth annual meeting at San Antonio, late last March. Outgoing WPRA president, Reid Brazell, also president of Leonard Refineries of Alma, Michigan, key-noted the symposium, saying that top management attitudes towards asphalt need to be changed.

Brazell thought that top managements' lack of interest and knowledge of asphalt is a reflection on the technical people in the refineries, the sales people, and the accounting departments. To counteract past and current attitudes, Brazell called on management to take a close look at the economics of asphalt manufacture vs residual fuel oil, and to realize that asphalt must be made from properly selected crudes, and that its quality must be rigidly controlled.

The asphalt manufacturer has a big selling point — asphalt is cheaper to install and maintain than concrete, and asphalt roads last longer. All the symposium spokesmen emphasized that the asphalt industry must educate the public and public officials on these advantages of asphalt and how it should be applied to make a high quality, smooth highway. Arvin S. Wellborn, chief engineer of the Asphalt Institute, made the point quite clear, stating the taxes on petroleum products will pay for a large part of the highway program. This same program that will make highways for cars to drive on, will cause higher taxes that in turn may restrain the motorist, due to higher prices. Since such is the case, said Wellborn, asphalt roads should be promoted in order to hold down costs — and taxes.

Asphalt specifications need overhauling, too. Too many grades for many years have plagued the refiner, but progress is being made. Just recently, the Asphalt Institute recommended that the number of paving grades be reduced from nine to five. And now, they are giving a lot of attention to reducing the number of cutback grades. According to D. W. Gagle of Phillips Petroleum Company, the American Association of Highway Officials, The Asphalt Institute, The Bureau of Public Roads and others have managed to reduce the number of asphalt grades to 44, with still too many nonconformists. Gagle said that many of the current tests are not realistic, but believes that improved tests are making a lot of headway.

A cheerful note is the headway that's being made on continuous blending systems for supplying cutback grades. The equipment is available, and it's dependable. The problem is one of establishing proper tests and getting officials at all levels to accept these tests as being reliable.

It's now possible that there will be an increased trend toward the use of solvent processes, according to Gagle, while discussing methods of manufacturing asphalts. He pointed out that it also may be possible to tailor-make asphalt, reproportioning the asphaltines, oils, and resins that make up the chemical structure of asphalt. Explaining further, he said that most authorities regard asphalt as a colloid made up of an asphaltine core surrounded by a resin coating, floating in an oil medium — a little more sophisticated than the classic definition "dark brown to black cementious material."

Still another area requiring improvement is the coordination of efforts between asphalt manufacturers and road-building contractors, according to Warren Warden, head of Miller-Warden Associates of Swarthsmore, Pennsylvania. Warden suggested during the symposium that asphalt manufacturers should establish sales engineering departments to aid road construction contractors in the proper use of asphalt. It's to be remembered that asphalt is not used as a homogeneous material in paving — rather it's mixed with aggregate of varying sizes to achieve desired properties. Too often, said Warden, the contractor does not have adequate knowledge of the many factors that effect the quality and appearance of the finished highway. Because of this great deficiency among the contractors, Warden feels that refiners must give more attention to the multitudinous problems of proper asphalt-mix preparation and application, should have engineers to go out and assist road construction contractors to do the job properly. This is perhaps the only way, he believes, that many instances of poor highways built with high quality asphalt can be avoided. ★ ★ ★

A unique tool handling system is one of the cost and time cutting procedures at Ohio Oil Company's Robinson refinery. Here's an inside look on how a medium-sized refinery is maintained

Maintenance in an Oil Refinery

Bert E. Newton
Maintenance Engineer
The Ohio Oil Company, Robinson, Illinois

IT is becoming apparent with each passing year that the maintenance departments in our petroleum refineries are being recognized by management as a very vital part in getting each barrel of petroleum products on the market. In this day of highly competitive business, management has brought processing and maintenance much closer together in an effort to produce products at a lower unit cost. With the thought that we are in a highly competitive business, it means simply that we must have better work order procedures, better records on equipment, better contacts with our metallurgy, inspection and design engineering departments, better turnaround practices and procedures, better methods to detect and control corrosion and the proper placing of maintenance personnel.

With these thoughts in mind let us give our refinery maintenance organization and its functions a close scrutiny in an attempt to help each other with the multitude of problems that confront us. Our plant would be classified as medium sized, processing 45,000 to 50,000 bbl of crude oil per day into the full category of finished products which are transported by truck, tank car, and pipeline to market.

Our processing units consist of the following: A full cut crude unit with vacuum section, fluid catalytic cracking unit, polymerization, stabilization and gas concentration section, alkylation unit, delayed coking unit, and a catalytic reforming unit. We also operate on a part time basis four Holmes-Manley thermal cracking units. Our power house delivers 220,000 lb of steam per hr and generates 10,000 kw of electrical energy. We have standby electrical service of about 40 percent of the total refinery load which is furnished by a public utility company. Of the approximately 650 employees in the refinery, 225 are in the maintenance department, divided into the crafts normally found in a refinery.

Condensed for THE REFINING ENGINEER by the author from a talk given at the January 1957 Plant Maintenance and Engineering Conference, Cleveland, Ohio.

WORK REQUEST No. _____

Unit Charge: _____ Date _____

Date to be completed _____ Approved by: _____ (BBM)

_____ Repairs to existing facilities _____ (DLW)

_____ Change to existing facilities

_____ New work Engineering _____ (CWL)

_____ Emergency — No. _____ Project Engr. _____

Purchase Orders issued _____ Engineering Complete _____

_____ Final approval: _____ (DLW)

_____ _____ (BBM)

_____ O. K. to issue W. O. _____ (JLH)

Work Description: _____

Requested by: _____

FIG. 1. **The original copy of the Work Request** is sent to the engineering department, who develops the information needed to make up a Work Order. A copy of the Work Request is routed to the plant superintendent, assistant superintendent, and then to the planning and scheduling department as a means of passing on pertinent information on the operations of the refinery.

Regular Work Order Procedure

Before any work other than an emergency job is done in the plant, it must be covered by a complete job description with an assigned work order number. It might be stated at this point that any of our foremen, engineers, or operators may originate the work request, upon which they describe the type and scope of the work they want done. A completion date is also placed on the request so that the maintenance department will have a guide in their scheduling of the work order. Before the work order is activated, it passes through three procedures:

1. All work requests (Fig. 1) are made out in duplicate, with the original going direct to the engineering department, the carbon copy is routed to the plant superintendent, to the assistant superintendent and then to the planning and scheduling department. Management approval is not required on these carbons, but they are sent to them as a means of passing on pertinent information concerning the operations of the refinery. The engineering supervisor determines what work requests require engineering, and immediately assigns the requests to area engineers, who contact the unit foreman and checks to be sure the work is necessary and warranted. If upon investigation the work request needs engineering, the area engineer devlops the job complete with blue prints, a job description, and a bill of material and then passes the work sheets and prints on to the maintenance supervisor who has the work order issued to cover the job. After the work order is issued (Fig. 2) with the attached prints and bills of material it is routed through the superintendent or the assistant superintendent for their approval after which the job is then released to maintenance for scheduling and completion.

2. If the work request does not require engineering it is routed directly to the maintenance supervisor for issuing, and follows the same route as the engineering orders in regard to securing approvals from management. After the work order is issued in triplicate it is reviewed by the planning and scheduling office and either scheduled for completion on a given date or placed in the back log for future processing, especially if it is the type of work that can be done in cold or rainy weather. We attempt to keep a back log of 5 to 10 percent to be processed when the work load is light.

3. When the work order is issued to the craft foreman for processing, one white copy is filed in the planning and scheduling office, one white copy is retained by the craft foreman and a pink copy is given to the craftsman who is to do the work. If more than one craft is involved originally, additional copies are made for each craft. However, if in processing the work, it becomes apparent that other crafts will be required and these crafts have not been issued a pink copy, an interdepartment order is used. It is attached to the craft copy upon completion so that the scheduling and planning office will know that all parts of the job covered by the work order are completed.

4. In every case the completed work order or orders, if more than one craft, must bear the name of the craftsman who has done the job, the signature of the originator who requested the work to be done, and the signature of the craft foreman. This gives both the maintenance foreman and the planning and scheduling departments a double check on all work orders, and at the same time has the written release from the originator of the work order.

5. Costs are tabulated monthly and distributed to the units that originated the requests and to the maintenance department so that a history can be made of the costs of the many types of maintenance functions that they are required

DISTRIBUTION:

Class:		
1	5	9
2	6	10
3	7x	11x
4	8	12

Area Engr. **R. A. Bates**
Acct. Dept.
Engr. Dept. 1
Originator 1 (#907)

WORK ORDER No. 9208
THE OHIO OIL COMPANY
ROBINSON REFINERY

Date: **July 3, 1956**

Unit Charge: **Delayed Coking Unit**
Equipment No.
CODE: 90-9208
Approved by: **D. L. Winsett** Issued by: **J. L. Hoelscher**
Requested by: **J. R. Price** To be Completed by: **August 30, 1956**

Work Description: **Install a platform at 262' elevation in the Coker structure for repairing swing joints and air motors on the coke drilling apparatus. Platform consists of stationary platform shown on Lummus Company drawings and movable platform shown on Ohio drawings.**

ENGINEERING DEPARTMENT

Drawing Numbers: **47-136; 47-137; E3169-176-4; E3169-197-3**
Purchase Order Numbers: **RX 27982; RX 27983**

Labor By Craft	ESTIMATED Hours	ESTIMATED Amount	ACTUAL Hours	ACTUAL Amount
1 Machine				
2 Elec.				
3 Instr.				
4 Carp.				
5 Paint				
6 Piping				
7 St. Main				
8 Tr. & Haul				
9 Labor				
10 Cr. & Hst.				
11 Wld. & Brn.				
12 Insul.				
R. P. Burden				
TOTAL				

MATERIALS	ESTIMATED	ACTUAL
Concrete & Mason		
Elec. Supplies		
Expen. Supplies		
Instrument		
Insul. & Supplies		
Lmbr. & Carp. Supplies		
Mach. Pumps Motors		
Paint & Supplies		
Pipe (Steel & Cast)		
Steel		
Tools		
Tubing		
Valves & Fittings		
Welding Supplies		
TOTAL		

Availability Tools and Materials
Estimate by
Time and Date Started
Work Completed by:
Time and Date Completed
Originator of Request

FIG. 2. **Work Orders are issued by maintenance supervisors** in accordance with the job description prepared by an area engineer. Work Orders are routed through the plant superintendent's office for approval, after which it goes to the maintenance department for scheduling and completion.

Recurring Work Orders

Unit	Work Order No.	Description	Date Issued
	1	Routine Checking of Instruments — not requiring dismantling	5-19-51
	2	Zeroing of Instruments — not requiring dismantling	5-19-51
	3	Visual Inspection of Instruments	5-19-51
	4	Routine Checking of Bearings — not requiring dismantling	5- 8-51
	5	Oiling and Greasing Equipment — not requiring dismantling	5- 8-51
	6	Visual Inspection of Equipment	5- 8-51
	7	Checking Lights	5- 8-51
	8	Replacement of Light Bulbs	5- 9-51
	9	Replacement of Fuses	5- 9-51
	10	Checking or Routine Inspection of Steam Traps	5- 9-51
	11	Time Considered as Operating Labor in the Maint. Department	5- 9-51
	12	Handling and Hauling Ammonia	5- 8-51
	13	Handling and Hauling Soda Ash	5- 8-51
	14	Handling and Hauling Tretolite	5- 8-51
	15	Handling and Hauling Liquid Caustic	5- 8-51
	16	Handling and Hauling Chlorine	5- 8-51
59	17	Handling and Hauling Ashes	5- 8-51
	18	Hauling Oil to I. C. Depot	6-20-51
	19	Truck Washing and Greasing	6-20-51
59	20	Loading and Unloading Coal	6-20-51
31	21	Repair and Maint. of Trucks, Autos, Cranes and Cats within Garage	
	22	Freeze-Up Work	12-18-51
74	24	Reclaiming Material	5- 3-51
	25	Handling and Hauling Refinery Supplies	5- 4-51
	26	Handling and Hauling Refinery Chemicals not on 12, 13, 14, 15 and 16	5- 4-51
30	27	Handling and Tending Goats	5- 8-51
24	28	Time Spent in Fire Drills	5-10-51
33	29	Time Spent in Safety Committee and Dept. Group Meetings	5-10-51
30	30	Mowing — Plant, Cafeteria and Office Grounds	5-15-51
32	31	Haul and Dump Material from Waste Containers (Outside Plant)	5-15-51
32	32	Haul and Dump Material from Waste Containers — Refinery Units	5-17-51
	33	Work in Office of J. L. Hoelscher on Maintenance Manuals, etc.	5-22-51
79	34	Haul Clay from Slop Oil Recovery Unit to City Dump	5-22-51
33	35	Crane Operators Time When Not Working on Specific Job	5-23-51
24	36	Once a Week Operation and Inspection of Gasoline Driven Fire Pump	5-24-51
26	37	Repairs to Welding Machines — Other than Complete Overhaul	6- 8-51
28	38	Maint. and Repair Phone System — All Hours (Revised 3-3-55)	6-28-51
44	39	Work Done with Design Engineers or Surveyors	10- 8-51
30	40	Clean Railroad Switches — Winter and Summer	12-18-51
28	41	Repairs to Mobile Radio Equipment	6- 2-52
49	42	Clear Warehouse Dock	6-19-52
5	43	Haul Spent Slurry to Burn Hole	6-20-52
33	44	Time Spent in Maintenance Instruction Courses	6-26-53
90	45	Remove and Handle Coke	7-28-53
49	46	"Round Robin" Deliveries from Warehouse throughout Plant	6-10-54
33	47	Sheehan Supervisory and Overhead Costs (Prorated to Productive Orders)	1-14-55
25	48	Minor Repair and Maintenance of Laboratory Instruments and Equipment	1-18-55
30	49	Cleaning Coal and Coke Transfer Tracks (all hours)	3- 3-55
	50	Checking and Repairing Pressure Gages	3- 3-55
	51	Checking, Re-setting and Repairing Smith & Varec Gages	3- 3-55
	52	Packing Valves (all hours)	3- 3-55
	53	Packing Pumps (all hours)	3- 3-55
30	54	Maintain Roads, Pavements, Ditches and Parking Lots	3-21-55
21	55	Repair Yard Pumps	3-22-55
25	56	Pick up aviation gasoline samples at different points	8-24-55

FIG. 3. **Routine maintenance is covered by re-occurring Work Orders** designed to eliminate much of the paperwork associated with "nonrecurring" jobs. Ed. note: Item 27, "Handling and Tending Goats," seems to offer interesting diversion from the more usual types of refinery work.

to do. These costs are used when estimates are made of comparable work requests.

Emergency Work Order Procedures

All emergency work is handled directly from the scheduling and planning office. In order to activate an emergency work order the person requesting the work calls the scheduling office for a work order number to cover the job, after securing permission to have the work done from the superintendent or assistant superintendent if they are available. The originator fills out an original and two carbons on the standard work order request form, sending the original to the engineering department for their information, one carbon through the plant superintendent's office, and using the second carbon copy for the craft head who has been called to do the work. Of course, we all have different definitions of an emergency. Some classify an emergency as work that causes a rescheduling of the crews after they have been given their daily job assignments. Others class emergency work as any job that affects the continued safe operation of equipment and units.

Re-occuring Work Orders

Our routine maintenance in the plant, such as repairing pressure gages, zeroing meters, telephone system repairs, hauling chemicals and all work of similar character is covered by what we have classed as re-occurring orders (Fig. 3) with identifying code numbers. Work done on these re-occurring orders is not identified by the use of our standard forms. Costs of the re-occurring work orders are tabulated monthly according to crafts and copies sent to all people concerned. If the costs of any craft or unit appear to be abnormal, the mechanics of the work is investigated so corrective measures can be taken if the costs were not justified.

Tool Sheets

As an aid to our maintenance department we have developed a tool manual for use by our craftsmen that speeds up any job 10 to 15 percent as regards any work on the equipment found in all of our major processing units, and the power house. These tool sheets (Fig. 4) show what tools are required in order to do a repair job on any piece of equipment, and in the case of exchangers and condensers it also gives information such as the number of tubes, the size and gage, the number and types of gaskets required, together with the bolting information.

For example, an exchanger develops trouble and has to be taken off stream for repairs. The planning and schedul-

ing office issues an emergency work order to cover the repair, and immediately contacts the craft foreman concerned for the proper crew selection. The tool room is notified that a specific exchanger is down for repair and they find the tool listing in the master tool book and assemble the tools so that when the repair crew moves to the job site they can stop at the tool room, where the tools have been placed in tote boxes, pick them up and continue on the job. In the event the repair crew comes from another area of the plant the tools are delivered to the job site by our plant delivery truck which makes a complete route at regular intervals. This tool sheet originated from the plant suggestion system and management agreed to put it into effect after making payment for the suggestion.

Turnaround Procedures

The turnarounds on our three larger units occur every 18 months on a scheduled basis, and on our smaller units on schedules of from six months to one year. We follow the same procedure on all of our turnarounds whether they be large or small and find that by so doing we can do a top flight job in the minimum of time allotted by the processing people. Planning on the next turnaround starts immediately after completion of the current turnaround. We also use our basic turnaround procedures on our boiler and turbo-generator turnarounds at the power house.

Pre-Turnaround

As an aid in estimating the time and cost of the new turnaround, manhour and cost records are kept for previous turnarounds. Monthly meetings are held with representatives of processing, engineering, maintenance and management in attendance. Repairs, new additions to existing equipment and piping or other changes are discussed at these meetings and decisions are made at this meeting on the detailed amount of work to be done. If any job requires engineering, it is placed with the engineering department for development and includes procuring suitable prints, writing up complete job descriptions and bills of material. As soon as this material is complete, the job is placed in the maintenance department hands so that if there is pre-turnaround work to do, it can be completed before the actual unit shutdown. Our metal inspection department develops a list of equipment to check and inspect and incorporates it with the process department's list of work.

After a final check which is normally made two weeks before turnaround, a final listing of all work is put out for each piece of equipment in the process unit affected. At this point our total estimate of manhours has been ascertained for the turnaround. We then check how many unit breakers will be available for turnaround work and establish the total manhours maintenance can supply. We have found that contract labor is normally required to the extent of 15 to 20 percent according to the size of the turnaround and the length of time we have to do the job.

The Author

Bert E. Newton is the maintenance engineer at The Ohio Oil Company's Robinson, Illinois plant. He is well-qualified to write on the subject of maintenance and engineering, having held positions such as senior engineer with the United States Department of the Interior, construction supervisor for Stearns Roger Manufacturing Company, and pipe and steel foreman for both The Texas Company and Sinclair Refining Company.

Turnaround Manpower

During turnaround our basic crews are composed of a gang leader and two helpers. If these crews are placed on jobs where more manpower is required, additional help is secured from the labor pool. On our stepped up crews, we do not step up any man that is below No. 1 helper classification to pusher. At the start of the turnaround these crews are handed individual work sheets on the equipment they are assigned to work on, and they are also given the time and date the job is scheduled for completion. These job assignments are made up for the entire turnaround by the planning and scheduling office and handed to each foreman, supervisor and gang pusher.

Turnaround-General

Our portable turnaround building is staffed by three clerks and a truck dispatcher. The three clerks handle all okays on the board work sheets for each unit, order all materials for the crews and handle all questions that pertain to the turnaround. All information in regard to approvals to do blinding, and to open any piece of equipment on the unit must be handled by the personnel in the turnaround building before maintenance men can do any work on the unit. After approvals have been placed on the board sheets by the operators, maintenance takes over and does the blinding and opening of equipment as listed, completing all work. Before "heading up" for testing, maintenance gets approvals from the metal inspection department and the operation department. After these approvals have been placed on the work sheets in the turnaround building, the final steam and hydrostatic testing is done. Relief valves are replaced and gagged, blinds are removed and the equipment is turned back to the process people. In *all* cases no approvals are given or accepted unless they clear through the turnaround building and carry the name of the person who has given the approval. By following this procedure, chance of error is held to an absolute minimum in the passing of information.

All oil, gas, water, steam, and other miscellaneous leaks in the processing units are marked with a metal tag, color coded for leaks, and assigned a number. Each tag is logged in a book at the control room so that the location can be ascertained. Valve packings, etc., are also handled on metal color coded tags bearing numbers. Two weeks before the unit comes down the complete leak and packing lists are issued to maintenance. We use a public address system to good advantage during our turnarounds since information can be passed on to men in the structure and in the limits of the unit area so they do not spend their time walking to and from their job to the turnaround headquarters or in answering telephone calls. Materials handling, etc., is greatly expedited by the extensive use of this type of equipment. We get full coverage of the turnaround area by placing speakers at suitable places in the pump rooms, throughout the area and in the unit structure itself.

Repair materials, etc., are unloaded in the unit at designated locations, which allows the workmen to get supplies — in most cases — within a matter of minutes. The delivery point in the unit for such material is given to the warehouse when the material order is called in. The heavier repair parts such as slide valves, cyclones, grid plates and other parts in this category are, of course, moved and raised to location at the most accessible point.

Chemical Cleaning and Turnaround

We do a moderate amount of chemical cleaning at our light ends plant and alkylation unit in towers, coolers and exchangers and up to the present time considerable success has been achieved by so doing. It has been our experience that to successfully chemically clean any equipment, a high rate of material circulation must be maintained at as high a temperature as the material will allow and with sufficient volume to cause entrainment of foreign material. Exchanger shells are hard to clean due to the baffles in most bundles and, chemical cleaning of the units pro-

cessing heavier oils has not been fully developed as yet, but we are satisfied there is a place for chemical cleaning in all the units if perhaps at only isolated locations. Refineries contemplating chemical cleaning can save many manhours and dollars by adding necessary stub connections for solution circulation when the units are down for repair and inspection.

Equipment Records

Equipment records are kept on all major pieces of mechanical and process equipment in order to maintain an inventory of parts that are of a critical nature. Equipment that has standby units afford the stocking of the minimum amount of replacement parts, since by using the spare it will allow sufficient time for repairs to be made on the equipment which has failed. We have found that on our pumps and compressors the greatest source of trouble is bearings and seals.

Corrosion and Erosion

Since corrosion causes maintenance many problems it must be mentioned along with our other maintenance procedures. It has been estimated by various surveys that the cost of corrosion to refiners is approximately $270,000,000 per year. It now becomes apparent that it is also a concern of the maintenance department since all repairs that are made by the maintenance department which were caused by corrosion have a direct effect on procedures and scheduling. The metallurgy department examines all equipment for general evidence of corrosion, erosion, fatigue and other general physical conditions during all of our turnarounds and are also called in on any other problems that arise on a day to day basis. They keep accurate and complete written records of all thicknesses and conditions as found. A constant check is kept on equipment and piping for changing corrosion conditions by checking process streams during operation by the use of hydrogen probes, water analysis, corrosion coupons, etc. By doing this, estimates can be made on replacements or repairs. This also allows time for proper materials to be procured and the down time scheduled when the retirement age of either equipment or pipe has arrived.

Protection of buried lines, tank bottoms, etc., is handled by the use of protective coatings and cathodic protection. The latter method is used extensively by our company. This type of protection reduces future maintenance costs but does require careful planning at the time of installation so the maximum amount of protection is offered with the initial installation cost. We also recognize that good painting practices

DA-1 Combination Tower
Item 6001

Sheet No. 2

Cleaning Equipment

3 — Cabinet Scrapers.
3 — 1½-in. Putty Knives.
1 — Hand narrow tray scoop.
2 — 14-qt galvanized buckets.
1 — P-9 Ampro pinch bar 18 in. long.
2 — ½-in. tail ropes.
4 — Whisk brooms.
1 — 1S-120 Buffer with 1½-in. long wire brush.
1 — Square point.

Safety Equipment

1 — Model 2 MSA Gas Tester.
3 — No. 909 Industrial gloves with knit wrist and neoprene covering.
Rain Suits.
Rain Pants.

Light Equipment

2 — 50-ft Drop light — 2 prong.
1 — 50-ft Extension cord.
1 — 3-Prong 4-way plug-in.
M.S.A. Air Mover — 3 in., 6 in., 10 in. if gas tower.
CS-16391 Air line respirator equipped with vision face piece, cartridge filter attachment.

DA-1 Combination Tower
Item 6001

Sheet No. 1

Gasket	Location	Bolt Size
Flg. No. 1	20-in. Manway at first tray 150 lb RF	1⅛ bolt — 1¼ opening
Flg. No. 1	20-in. Manway at No. 7 tray 150 lb RF	1⅛ bolt, hex nut, 1¼ opening
Flg. No. 1	20-in. Manway at No. 12 tray 150 lb RF	1⅛ bolt, hex nut, 1¼ opening
Flg. No. 1	20-in. Manway at Liquid Level 150 lb RF	1⅛ bolt, hex nut, 1¼ opening
Flg. No. 3	12-in. Feed from DA-2A-2B 300 lb RF	1⅛ bolt, hex nut, 1¼ opening
Flg. No. 4	12 in. Vapor out to EA-1 150 lb RF	1⅛ bolt, hex nut, 1¼ opening

Unheading and Heading Up

1 — 538 Nut Gun.
1 — 1M-583 Hex Socket with 1¼-in. opening — Manways.
1 — 8811 — 1⅛ Sledging Wrench.
1 — 8911 — 1⅛ L. H. Box.
1 — 43 — End Wrench.
1 — 12-lb Sledge.
4 — Jts. Air Hose.

Tray Bolt Tools

1 — 504 Nut Gun with ½-in. sq. drive.
1 — S-115-P — Extension Bar ½ in. x 10 in. long.
1 — S-115-P — Extension Bar ½ in. x 5 in. long.
1 — ⅞-in. hex deep socket with ½-in. sq. drive.
1 — ⅝-in. hex deep socket with ½-in. sq. drive.
1 — ¼-in. hex deep socket with ½-in. sq. drive.
1 — ½-in. Universal Joint.
1 — S-52 Rachet with ½-in. sq. drive.

FIG. 4. **Tool sheets show exactly what tools are required** to do a repair job on any piece of equipment. The tool room keeps a master tool book, can assemble proper tools immediately upon notification that a specific unit is down for repairs.

are essential for control and prevention of corrosion. There is no one system of painting or any one paint that is suitable for an entire refinery. Each unit or area must be considered separately due to various gas or chemical conditions. The work in any part of the refinery must be prepared properly and the application of paint rigidly supervised in order to obtain the maximum results.

Maintenance Personnel

We fill all of our maintenance positions below foreman and sub-foreman levels by the bid method. The job with a description of the duties to be performed is posted and bids are invited. Any man in the plant has the privilege of bidding on these advertised jobs whether he be from maintenance or processing. The bids are posted for about a five-day period. When all bids are in, the personnel department together with management, the department foreman, and the applicant's former supervisor sit down and review all applicants as to education, plant experience, physical fitness, etc. Both seniority and training are considered when making the decision as to which employee will be selected for the job.

Our sub-foremen and foremen are selected from the maintenance department personnel after they have demonstrated characteristics that would tend to show they have supervisory qualities. When such an employee is found, he is given training on the job to develop his leadership qualities. These men are sometimes trained for a year or more before a position will open up where they can be placed on a trial basis on their own merits. Our employees like this type of selection very much because they all realize that each one will be given an equal opportunity when advancements are made. ★ ★ ★

FIG. 1. Chemical solvents are widely used to remove sludge and deposits from refinery storage tanks. Such solvents are applied through specially-designed tools that make possible rapid and efficient cleaning.

P 937.0

Chemical Cleaning of Storage Tanks

is even more effective than before, thanks to recently developed mechanical methods of applying solvents for removal of scale deposits and sludge

L. E. West
and B. L. Canaday
Dowell Incorporated, Tulsa, Oklahoma

CHEMICAL solvents are being widely used in refineries to solve the difficult problems of removing sludge and scale deposits from storage tanks. Chemical cleaning methods have been given further impetus by the development of specially-designed mechanical tools for applying liquid solvents.

Chemical solvents have been used for the removal of fouling deposits from refinery equipment for many years. The speed and economy of chemical cleaning have made it a popular maintenance tool. It has proved especially valuable in the cleaning of large-capacity storage tanks which, due to their size and structure, are difficult to clean mechanically. Sand blasting such structures becomes extremely unpleasant for maintenance personnel, and such an operation is costly and time-consuming.

By contrast, suitable chemical solvents can be used to dissolve or loosen the unwanted material from the tank surfaces with a maximum of efficiency and a minimum of exposure of maintenance personnel to hazardous conditions. Recently developed mechanical methods of applying the solvents have made chemical cleaning even more effective than before. These application tools can be remotely controlled. In most cases they eliminate the need for exposing personnel to hazardous dust or fume conditions.

Why Tanks Must Be Cleaned

Thorough cleaning of large storage tanks is desirable in a refinery for several reasons. A common one is the build-up of rust or sludge deposits on the interior of the tank, which may in time lower the quality of the product being stored. Often it may be desirable to convert a storage tank from crude or impure petroleum product storage service to storage of a highly refined product. In such cases, sludge residues or deposits within the tank would discolor or contaminate the refined product.

It is also desirable, wherever possible, during plant turnarounds or other temporary periods of non-use to conduct periodic inspections of storage facilities to detect corrosion or necessary repairs. Prior to such inspection, the tank must be cleaned of all rust deposits and organic residues in order that any operational corrosion may be properly evaluated. Storage tanks should also be thoroughly cleaned prior to applying paint or protective coatings. Often mill scale is removed from new tanks being readied for service.

Steps in the Cleaning Operation

The first step in conducting a tank-cleaning operation is a thorough evaluation of the problem. This includes a study of the tank structure, insofar as size, internal bracings or obstructions, associated piping, and metals of construction are involved. Prior study of the scale or sludge deposits is also essential, in order that the most efficient solvents and application techniques may be chosen for the cleaning operation.

Selection of the solvent, or solvents, to be used depends upon the nature of the deposit encountered. If the scale is composed largely of rust, oxides or salt deposits, an acid solvent is usually employed to dissolve it. If an oily or greasy film must be removed from the

FIG. 2. The Zingger shown here applies cleaning solvents to internal tank surfaces at high pressures. It is designed so that it rotates through 360° both horizontally and vertically, thus contacting virtually all tank surfaces with the jet streams from its two nozzles.

tank interior, water or alkaline solutions containing a detergent may be used for the degreasing operation. The removal of paraffinic or asphaltic residues may prove more difficult, requiring light oil or chlorinated hydrocarbon solvents.

If mixtures of organic materials and inorganic oxides are encountered, emulsified solvents may be employed in order to secure the combined dissolving action of an organic solvent and an aqueous acid or alkaline solution. Occasionally, deposits may be encountered which are extremely difficult to remove, usually due to aging or polymerization of organic material. In such cases, a number of solvents, applied in stages, may be necessary for the complete removal of the deposit. This condition, however, is infrequent.

The simplest method of applying the solvent is to fill the tank and allow it to soak until all of the scale or sludge has been disintegrated. The tank can then be flushed out and returned to service. With most large storage tanks, however, the volume of solvent required to fill the tank would be both impractical and uneconomical.

To overcome this difficulty, an automatic spraying unit called a "Zingger" has been designed for cleaning tank interiors. Construction of this spraying unit is shown in Fig. 2. The cleaning solvents are pumped through orifices in the spraying head of this machine under high pressure. This results in a high-velocity solvent stream which, as the unit revolves, reaches every portion of the tank, including otherwise inaccessible crevices between plates or behind structural braces. The rotation of this device is controlled by a small hydraulic motor in the base of the machine. Once the Zingger has been installed in the storage tank and the connecting lines laid, there is no necessity for any personnel to enter the tank until the cleaning operation has been completed. This is particularly advantageous where poisonous gases may be generated during the cleaning operation. Other specialized spraying equipment has also been developed for cleaning the external surfaces of storage tanks.

When using the spraying method for cleaning interiors of tanks that can be readily drained, it may be desirable to circulate the solvent, picking it up at the bottom of the tank and pumping it back to the sprays, until either the solvent is spent or all of the deposit is removed. However, it is usually more practical to use fresh solvent and allow the used solvent to drain away. Dislodged solids in the solvent often make re-circulating difficult and causes plugging of the jet orifices.

The use of thickened solvents has been successfully applied to the problem of tank cleaning. In such cases, a gelling agent is added to the solvent to make it thick and viscous so that, after it has been sprayed onto the tank walls, it does not run off but forms a jelly-like coating. This allows the solvent to react with the deposits for a longer period of time, and eliminates the necessity for recycling the solvent. After the thickened solvent has had sufficient time to react with the deposits, it is readily flushed off with water. If acid solvents have been used, or if the tank is being prepared for painting, it is desirable to follow the cleaning treatment with a passivating solution to prevent after-rusting.

The following case histories illustrate typical refinery tank cleaning problems and how they were solved using chemical cleaning techniques.

Case History A: How a Crude Oil Tank Was Cleaned

A 120-ft, floating-roof tank that had been in crude oil storage service was to be cleaned in preparation for welding and repairs. An estimated 90,000 gal of heavy bottom sediment was in the tank. This sludge was successfully removed by the use of a light oil solvent, and by applying heat through auxiliary steam lines. This solvent was applied through Zinggers, the liquefied sludge then being pumped directly into the crude oil line going to the still.

Six Zinggers were placed inside the tank, evenly spaced in a circle twenty feet from the tank walls (Fig. 3). Three of the Zinggers were conventional machines, with full 360° coverage, both vertically and horizontally. The other three machines were inverted and modified so that the fluid jets operated in a horizontal plane only, about 2 in. from the bottom of the tank. All six machines were connected by copper wire to a driven ground outside the tank, so that dangerous static charges would be drawn off.

A steam line from the tank farm's steam supply was run to a header inside the tank. From this header, nine, 100-ft lengths of ½-in. spiral-wound electrical conduit were run. These lengths of conduit were spaced about the tank so that all parts of the tank bottom could be heated. The loosely-wound construction of the conduit allowed live steam to leak out along its entire length.

Plywood bulkheads were placed over the manholes after the equipment was installed, and packing was placed around the hose entrance so that the tank was sufficiently airtight to hold carbon dioxide. Enough CO_2 was then put into the tank to bring its oxygen content down to 11 percent, safely under the 14.2 percent at which the atmosphere can support combustion.

Steam passed through the conduit network heated the sludge so that much of it was liquefied. About 40,000 gal of this liquefied bottom sediment was pumped off. A light oil solvent was then applied through the six Zinggers in

The Authors

L. E. West

B. L. Canaday

L. E. West was graduated from Cornell University in 1922 with a BS degree in chemical engineering. He joined Dowell Incorporated in 1943 as a service engineer at Salem, Illinois. In 1943, he became sales engineer at Chicago, and in 1945 he was promoted to district sales engineer, serving in this capacity first at Philadelphia, then at Houston. In 1943 he became a general sales engineer at Dowell's Tulsa headquarters.

B. L. Canaday was graduated from Kansas State University in 1951 with a BS in mechanical engineering. In 1951 he joined Dowell Incorporated as a junior service engineer at Wilmington, Delaware. In 1951 he became a service engineer. He was appointed service engineer at Baltimore in 1952, and in 1953 became sales engineer at Baltimore. In 1956 he became mechanical engineer at Mt. Holly, Illinois, and in 1957 was promoted to field development engineer in Dowell's Tulsa general office.

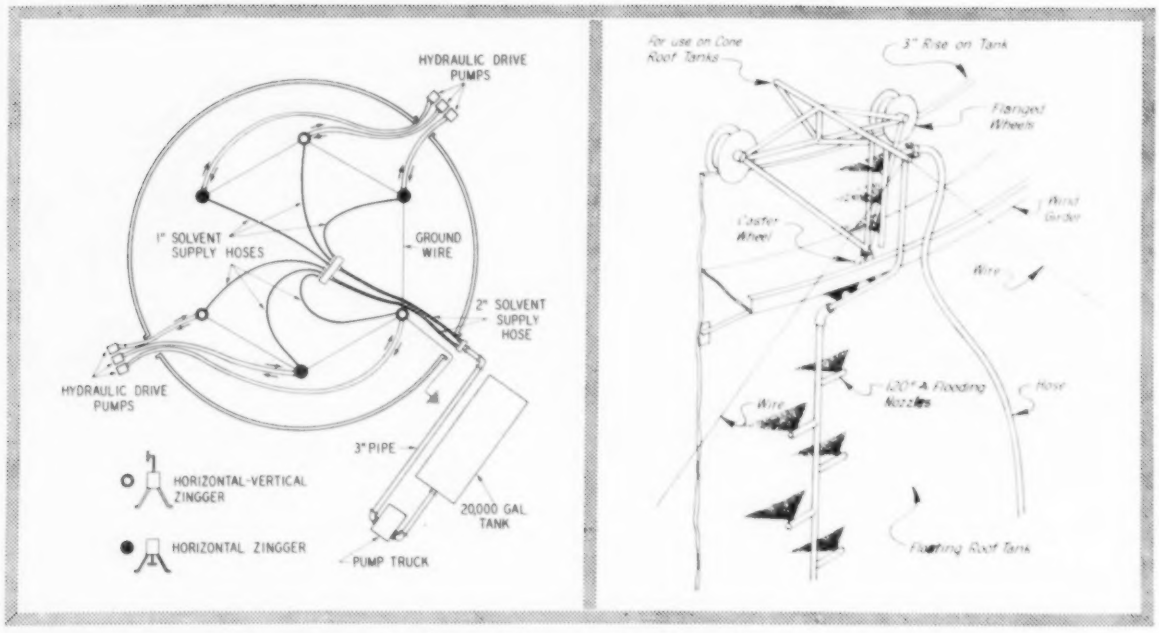


FIG. 3. This is a diagram of the arrangement of six Zinggers inside a 120-ft tank being cleaned to prepare it for welding. Three of these machines are like the one shown in Figure 2. The other three were inverted and arranged so that the jets of solvent stayed in a horizontal plane.

FIG. 4. This special tool is designed to flood exterior tank walls with chemical slovents. It rides around the top of the tank, being pulled by wires. Although the tool is shown in place on a floating-roof tank, it can be readily adapted for cone-roof tanks.

three separate stages. The first stage consisted of 18,000 gal of solvent, and a total of about 50,000 gal of solvent and liquefied bottom sediment was pumped off. In the second stage, another 18,000 gal of the solvent was applied, and some 30,000 gal of solvent and sediment was pumped off. A third stage of 18,000 gal was applied, and approximately 20,000 gal of solvent and sediment was pumped away.

At this point, one of the operator's inspectors said that the tank was clean enough, as it was, for gasoline storage. Equipment was then removed from the tank and the bottom of the tank was squeegeed. The following morning, the tank bottom was completely dry and clean. An absorbent clay was spread over the tank bottom and swept up. The tank was then considered safe for welding operations. A similar tank on this farm had previously been cleaned manually. This job required 12 weeks. In contrast, the chemically cleaned tank required only five days.

Case History B: Removal of TEL Deposits

Tetraethyl lead deposits within tanks present a serious safety hazard to personnel entering the tank. Although such deposits can be removed rapidly by hand scraping, the danger of poisoning involved makes it desirable to use some other method.

A 73-ft, floating roof tank, 40 ft high, was recently cleaned to decontaminate it by removing tetraethyl lead, and to remove iron oxide. Three Zinggers were set up inside the tank. Because personnel were in the tank such a short time, no safety precautions were necessary other than the normal use of fresh air masks. Concentrated inhibited hydrochloric acid (38 percent) was applied through the Zinggers at 1100 psi. The acid was allowed to react for two hours. Tank walls and roof were then washed down with 1250 gal of water, applied at 1600 psi, and the diluted acid was permitted to soak the tank bottom for another two hours.

FIG. 5. This is a photograph of a large storage tank being cleaned of mill scale. The walls are being washed with hydrochloric acid.

Five thousand gallons of wash water were then pumped into the tank on one side, while the acid solution was being pumped off at the opposite side. When all the liquid was pumped away, jets of water, applied through hand lances, were used to flush the loose solid materials on the tank floor to a manhole. The water was then pumped off and these solid materials were shoveled out the manhole. When the tank was inspected, it was found to be lead-free.

The total time required for cleaning on this particular tank was three working days. However, a tank of this size can sometimes be cleaned in two working days when all conditions are favorable.

Case History C: Cleaning Tank Exteriors Before Painting

Cleaning exterior walls of storage tanks has long been a serious problem in the petroleum industry. New tanks being placed in service should have all mill scale and rust removed from them before painting, and old tanks often must have paint and rust removed. Until a method of removing such deposits with chemical solvents applied hydraulically was developed, no completely satisfactory solution to the problem was available.

Recently a special spraying tool, Fig. 4, has been designed which makes it

possible to clean exterior walls of storage tanks economically and rapidly. For example, a large 120 ft by 52 ft tank was recently cleaned to remove mill scale and rust in about two working days. Although the illustration shows the tool in place on a floating-roof type tank, it can also be adapted for use on cone-roof tanks. The trolley arrangement makes it possible to move the tool around the tank walls so that cleaning solution can be sprayed on all wall surfaces.

Before this cleaning treatment was begun, all loose rust and mill scale was swept away from the tank. A strip-off paint was applied to the base of the tank to fill the space between the base and the concrete pad. This coating prevented acid from running under the tank. The entire concrete base, pads, and sump were then painted to prevent etching by the acid.

Inhibited acid was pumped through the tool and sprayed on the surface of the tank. After the tank wall was wet with acid all around, it was allowed to soak for twenty or thirty minutes before the next acid stage was applied. Hand lancing was used to spray acid against some portions of the ladders and wind girders that could not be reached with the tool.

Representative Costs of Cleaning Tank Exteriors.

Tank Number	Problem	Unit Cost	Size
1	Rust and mill scale	15.2 cents/sq ft	4,000 sq ft
2	Paint and rust	22.9 cents/sq ft	8,532 sq ft
3	Paint and rust	12.8 cents/sq ft	14,958 sq ft
4	Rust and mill scale	11.9 cents/sq ft	17,661 sq ft
5	Rust and mill scale	17.6 cents/sq ft	7,536 sq ft
6	Rust and mill scale	18.4 cents/sq ft	7,536 sq ft
7	Paint and rust	17.2 cents/sq ft	8,532 sq ft

This cleaning job required 3000 gal of concentrated inhibited acid, amounting to about eight gal per linear foot of the tank base. Part of this acid was spent on the iron oxide, some of it evaporated from the tank surface, and the rest ran off at the base. The disposal of this acid was not particularly difficult. Most of it was flushed away into the regular drainage system. Any residual pools on the ground were neutralized with soda ash.

After all of the iron oxide was removed from the tank exterior, it was washed with water, followed by a passivating solution. This cleaning treatment made the tank easy to paint. Both prime coat and finish coat went on easily, without any of the problems encountered in painting rough, sand-blasted surfaces.

One operator reports that the money savings in using this cleaning method rather than sand blasting amount to about one-half of the cost of sand blasting. Because of the six to eight days required to sand-blast a large tank, a full rust bloom can be expected on most tanks before they can be painted. In the case of chemical cleaning, a passive surface is available for painting the following day, with very little rust bloom present on the tank.

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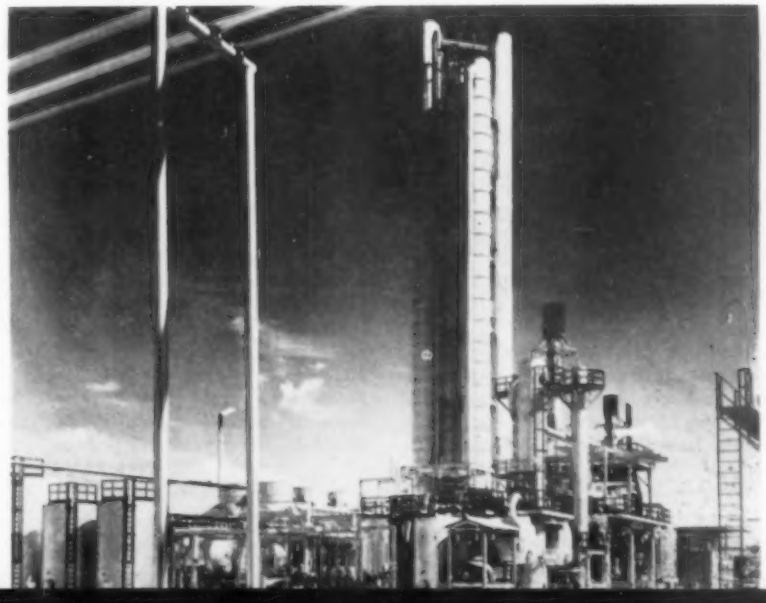
NEW Styrene Plant Dedicated

The world's only plant producing styrene by direct recovery of ethylbenzene from gasoline was officially dedicated on April 3, at ceremonies held at Cosden Petroleum Corporation's 27,000 B/D Big Spring, Texas, refinery. The $3 million plant was built by Badger Manufacturing Company and is designed to produce more than 20 million lb per year of styrene. Cosden is marketing the product for use as an intermediate material in the manufacture of plastics and synthetic rubber.

Feedstock for the styrene plant is a mixture of xylenes from Cosden's BTX plant . . . consisting of a Platformer, Udex Extraction unit, and distillation towers to separate the benzene-toluene-xylene fractions. The ethylbenzene is separated from xylenes in super-fractionating columns with a boiling point differential of only four degrees between the stream constituents.

After the critical boiling point separation, the ethylbenzene is converted to styrene — $C_6H_5CH = CH_2$ — by dehydrogenation. Purity of the product is more than 99.2 percent.

An interesting note for size-conscious Texans is the fact that the tallest of the four towers shown in the picture is over 20 stories high, the tallest structure in West Texas.



Aerial view of Kwinana refinery jetty and water intake flume.

P 750.

Elaborate plan prevents galvanic action between sea water and steel to minimize corrosion

Cathodic Protection System For Refinery Jetties

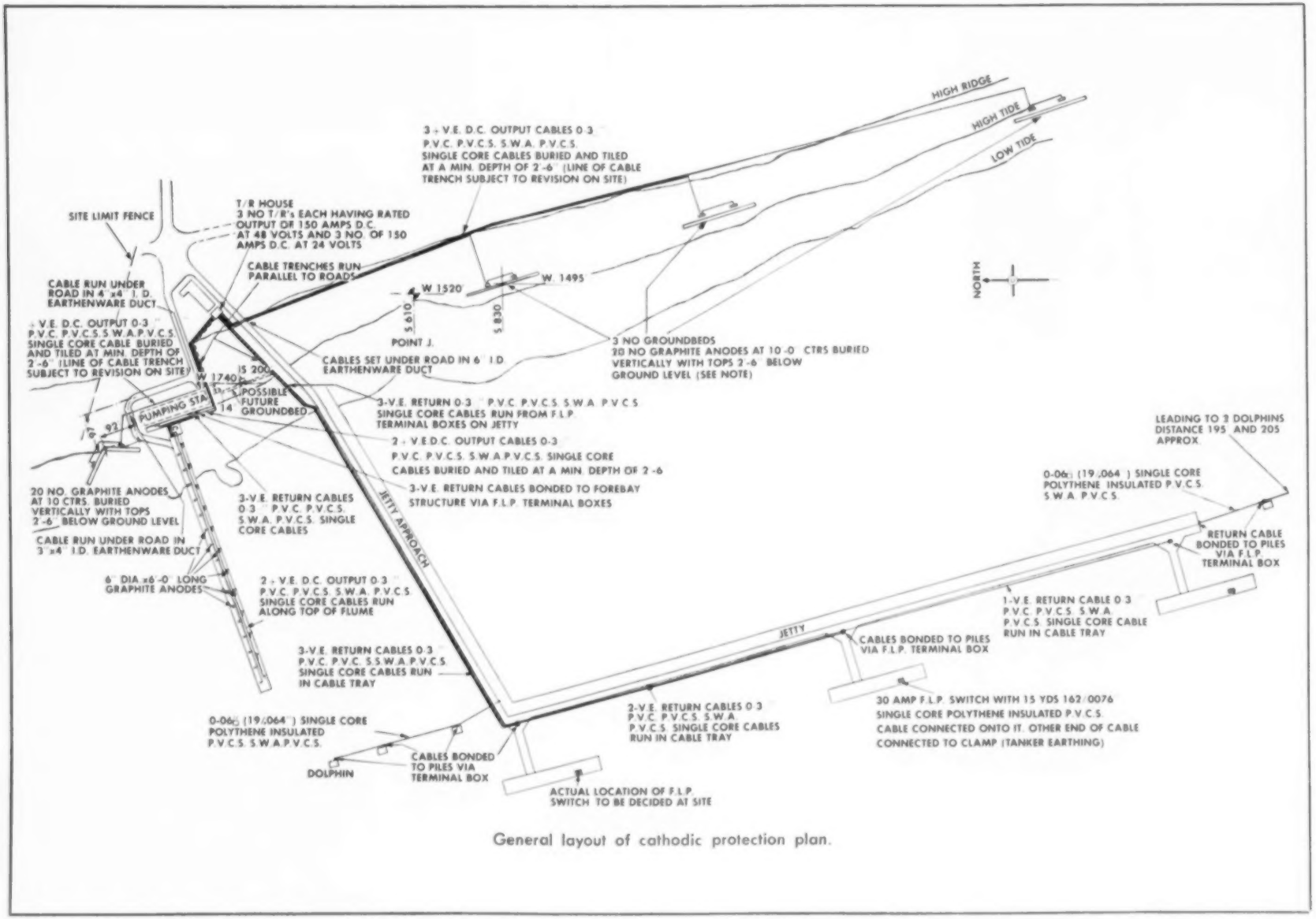
Walter Sekules
European Correspondent

UNDERWATER steelwork at Kwinana Refinery, near Tremantle, Western Australia, is fully protected against corrosion by a power-impressed cathodic protection system designed by K. A. Spencer, consulting engineer, London, England. Australia's largest refinery, Kwinana, operated by Australasian Petroleum Refinery, Ltd., an associate of the British Petroleum Company group, has been designed for a throughput of 3,000,000 tons of crude oil per year.

Buried pipe lines and tank bottoms did not require cathodic protection since the soil at the refinery site is virtually noncorrosive. Marine structures above the low water mark could be effectively protected by impervious coatings. Permanently submerged steelwork, however, requires special protection because the coating generally suffers damage due to ground friction and shock applied by pile drivers and due to long-term effect of marine growths. Cathodic protection will prevent corrosion at faults in the pile coating.

Corrosion of submerged metal is associated with a natural flow of direct electric current from the metal to the sea water electrolyte. In a cathodic protection system, direct current is caused to flow from the electrolyte to the metal, so that metal ions cannot leave the steel and pass into solution. To insure protection, the metal must be held sufficiently electro-negative at the metal-electrolyte interface to prevent positively charged ions leaving the metal surface. To achieve this, the metal-sea water potential is depressed — a value of —0.85 to —0.95 v relative to a copper-copper sulfate half-cell is regarded as satisfactory. The current required to produce the necessary depression of the metal-sea water potential is related directly to the area of metal exposed to the electrolyte, and, therefore, it is dependent on the quality of the coating on the installed structure.

Two main systems of cathodic protection are available. The first utilizes galvanic anodes — usually made of magnesium — which have a higher natural potential than steel and thus provide current for protection by forming a galvanic cell with the steel. At Kwinana, current requirements are fairly high, and if galvanic anodes had been used, a large quantity would have had to be distributed around the struc-


HIGH RIDGE
HIGH TIDE
LOW TIDE
NORTH
3 + V.E. D.C. OUTPUT CABLES 0·3" P.V.C. P.V.C.S. S.W.A. P.V.C.S. SINGLE CORE CABLES BURIED AND TILED AT A MIN. DEPTH OF 2'-6" (LINE OF CABLE TRENCH SUBJECT TO REVISION ON SITE)
SITE LIMIT FENCE
T/R HOUSE 3 NO T/R's EACH HAVING RATED OUTPUT OF 150 AMPS D.C. AT 48 VOLTS AND 3 NO. OF 150 AMPS D.C. AT 24 VOLTS
CABLE TRENCHES RUN PARALLEL TO ROADS
CABLE RUN UNDER ROAD IN 4" x4" I.D. EARTHENWARE DUCT
W 1520
W. 1495
S 610
S 830
POINT J.
3 NO GROUNDBEDS 20 NO GRAPHITE ANODES AT 10·0" CTRS BURIED VERTICALLY WITH TOPS 2'-6" BELOW GROUND LEVEL (SEE NOTE)
+ V.E. D.C. OUTPUT 0·3" P.V.C. P.V.C.S. S.W.A. P.V.C.S. SINGLE CORE CABLE BURIED AND TILED AT MIN. DEPTH OF 2'-6" (LINE OF CABLE TRENCH SUBJECT TO REVISION ON SITE)
CABLES SET UNDER ROAD IN 6" I.D. EARTHENWARE DUCT
W 1740
S 200
POSSIBLE FUTURE GROUNDBED
PUMPING STA
3-V.E. RETURN 0·3" P.V.C. P.V.C.S. S.W.A. P.V.C.S. SINGLE CORE CABLES RUN FROM F.L.P. TERMINAL BOXES ON JETTY
2 - V.E.D.C. OUTPUT CABLES 0·3" P.V.C. P.V.C.S. S.W.A.P.V.C.S. SINGLE CORE CABLES BURIED AND TILED AT A MIN. DEPTH OF 2'-6"
3-V.E. RETURN CABLES BONDED TO FOREBAY STRUCTURE VIA F.L.P. TERMINAL BOXES
LEADING TO 3 DOLPHINS DISTANCE 195' AND 205' APPROX.
0·06" (19·064") SINGLE CORE POLYTHENE INSULATED P.V.C.S. S.W.A. P.V.C.S.
20 NO. GRAPHITE ANODES AT 10 CTRS. BURIED VERTICALLY WITH TOPS 2'-6" BELOW GROUND LEVEL
3-V.E. RETURN CABLES 0·3" P.V.C. P.V.C.S. S.W.A. P.V.C.S. SINGLE CORE CABLES
JETTY APPROACH
RETURN CABLE BONDED TO PILES VIA F.L.P. TERMINAL BOX
CABLE RUN UNDER ROAD IN 3"x4" I.D. EARTHENWARE DUCT
6" DIA x6'-0" LONG GRAPHITE ANODES
2 - V.E. D.C. OUTPUT 0·3" P.V.C. P.V.C.S. S.W.A. P.V.C.S. SINGLE CORE CABLES RUN ALONG TOP OF FLUME
JETTY
1-V.E. RETURN CABLE 0·3" P.V.C. P.V.C.S. S.W.A. P.V.C.S. SINGLE CORE CABLE RUN IN CABLE TRAY
CABLES BONDED TO PILES VIA F.L.P. TERMINAL BOX
3-V.E. RETURN CABLES 0·3" P.V.C. P.V.C.S. S.W.A. P.V.C.S. SINGLE CORE CABLES RUN IN CABLE TRAY
0·06" (19·064") SINGLE CORE POLYTHENE INSULATED P.V.C.S. S.W.A. P.V.C.S.
2-V.E. RETURN CABLES 0·3" P.V.C. P.V.C.S. S.W.A. P.V.C.S. SINGLE CORE CABLES RUN IN CABLE TRAY
30 AMP F.L.P. SWITCH WITH 15 YDS 162/0076 SINGLE CORE POLYTHENE INSULATED P.V.C.S. CABLE CONNECTED ONTO IT. OTHER END OF CABLE CONNECTED TO CLAMP (TANKER EARTHING)
DOLPHIN
CABLES BONDED TO PILES VIA TERMINAL BOX
ACTUAL LOCATION OF F.L.P. SWITCH TO BE DECIDED AT SITE

General layout of cathodic protection plan.

Cathodic house, which covers transformer/rectifiers.

View of water intake flume, from cathodic house.

ture and would have needed periodic replacement. It was, therefore, decided to adopt the alternative power-impressed system in which current is supplied from an external d-c source. It enables the use of groundbeds utilizing graphite anodes, which have an indefinitely long life — an estimated 40 years in the case of Kwinana. Another advantage of this system is the very fine degree of control available over the system through the variation of d-c output from the rectifiers.

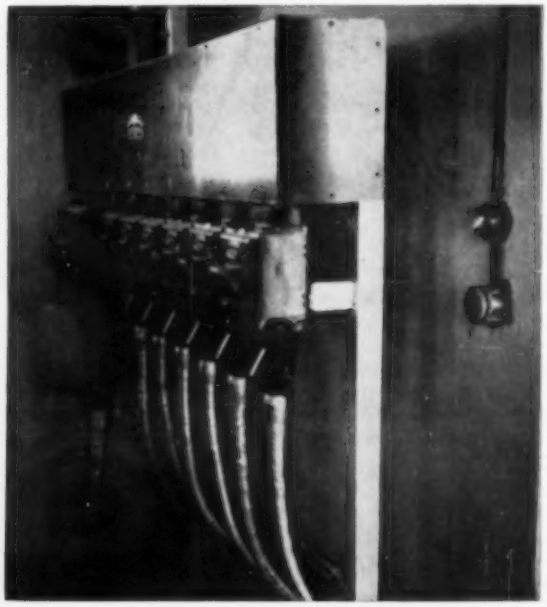
This installation at the Australian refinery protects the refinery jetty and the sea water intake flume. Transformer-rectifiers for both are housed in a common building, otherwise the two installations are separate. The coating applied to the submerged steelwork of both structures was identical.

According to Spencer, cold-applied coatings, which harden by the evaporation of diluents and leave a protective layer of only a few thousandths of an inch thickness, are unsatisfactory for permanently submerged steel. His coating specifications call for cleaning, or preferably sand-blasting, cold priming with asphaltic enamel primer, followed when this is dry by a hot-applied coat of asphaltic enamel at least 3/32 to ⅛ in. thick. During the driving of the piles, damage to the coating is repaired so far as possible. At Kwinana, the sheet piles of the water intake flume were coated over their full length and the box piles of the jetty to within 10 ft of the bottom — it was impossible here to apply a complete coating for civil engineering reasons.

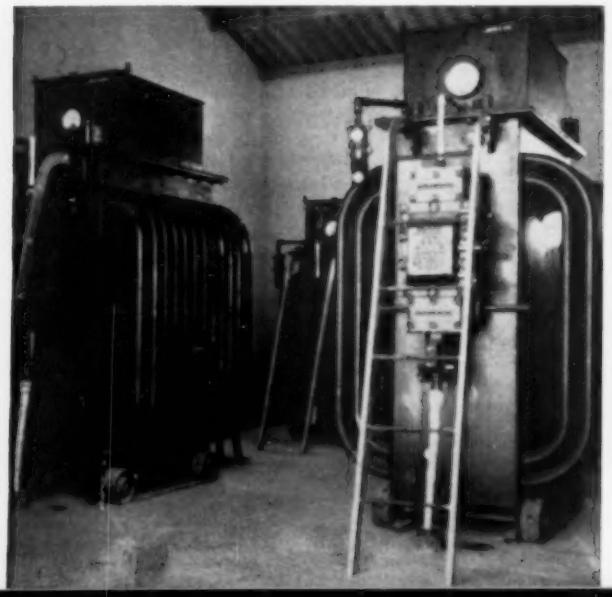
The jetty at Kwinana can accommodate up to three 32,000-ton tankers simultaneously. It consists of steel box piles with concrete muffs and a superstructure of precast concrete units, forming the roadway and pile track supports. It was necessary to bond the piles together electrically without disturbing the pleasing effect of the structure.

A 1⅛-in. steel bar, bitumen-primed and wrapped with adhesive PVC tape, was cleated to the underside of the longitudinal members and run the full length of the structure, one rod on each side. Connection to individual piles was made with steel strip welded to the pile and to the rod. At the shore end of the approach and at the extreme end of the trunkway, the two rows of bonded piles were connected with a length of steel angle-welded across the piles. The three isolated mooring dolphins at each end of the jetty were bonded together with polythene-insulated cable laid on the sea bed and connected to each dolphin and the main jetty by special bonding boxes

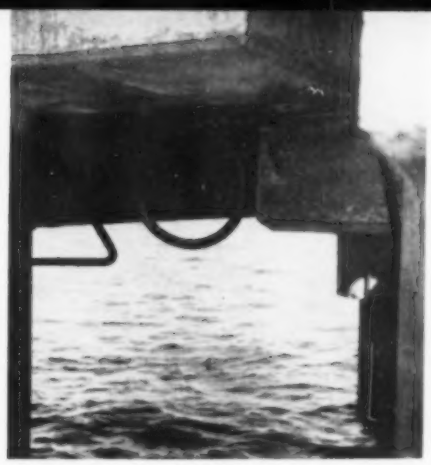
Right, A-C distribution panel in the cathodic house.



Interior of cathodic house, with two transformer/rectifiers, in front of three units taking care of the flume.



Details of underside of jetty approach and of pile bonding; angle iron welded across piles in foreground.



Expansion loop in bonding rod at junction of jetty approach and trunkway.

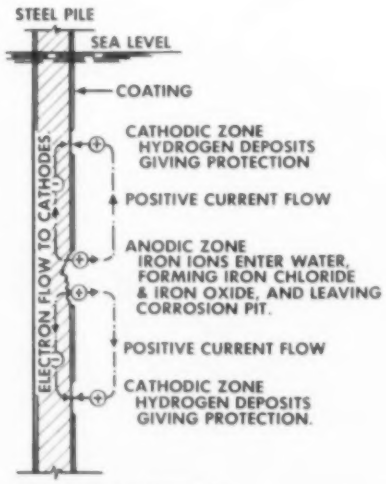
Bonding of jetty piles at shore end of approach; rod shown is welded to pile on right, connection to pile on left.

above the high-water mark.

Three groundbeds, each fed by a transformer-rectifier, are located in the foreshore opposite the jetty trunkway. Each consists of 20 graphite anodes, laid horizontally and contained in burlap sacks packed with carbonaceous backfill. Anodes are spaced at 10-ft intervals at an average burial depth of 3 ft 6 in. The three transformer-rectifiers each have a continuous maximum rating of 165 amp d-c in an ambient temperature of 40 C. Terminal voltage can be varied by rotary switching between 2.5 and 48 v.

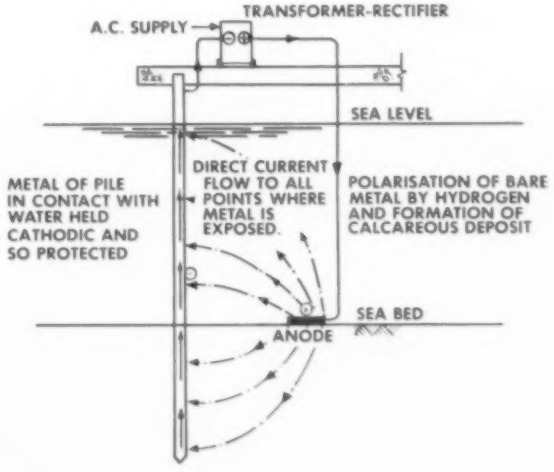
On each of the jetty heads, 60-amp, flameproof switches are connected to cables with special bonding clamps that allow tankers to be electrically bonded to the steelwork of the jetty. This bond is made before hoses are connected to the tanker and is broken only when the hoses have been removed. This system is designed to meet static electricity safety regulations, but it is also suitable for a jetty under cathodic protection.

When the jetty installation had been partially, and the bonding work fully, completed an electric drainage test was made by applying a heavy current to various sections, using an electric welding set and temporary steel anodes placed in the sea. The structure was polarized by causing a current of 300 amp to flow to the dolphins and each of the jetty heads in turn for a period of three days. It was found that rough water depolarized the structure fairly quickly. To obtain better current distribution, the locations of the external groundbeds were moved, each being placed in the beach just below high-water mark and approximately opposite to the jetty heads. When the permanent installation was finally switched on, the average potential for for the whole structure was found to be —0.91 v relative to a copper-copper sulfate half cell. Total a-c power input to the transformer-rectifiers was 12 kva, but consumption was likely to go down as calcareous deposits were built up on exposed submerged metal.



CORROSION MECHANISM.

At the anodic zone the metal is more electropositive to the sea than at the cathodic zone, so positive iron ions enter the water and are oxidised to iron oxide and iron chloride. Simultaneously, positive hydrogen ions are neutralised to form hydrogen molecules at the cathode by negative electrons.



CATHODIC PROTECTION MECHANISM.

Direct positive current flows from anode ground bed to all exposed metal in contact with electrolyte preventing iron ions leaving metal surface, since metal is electro-negative to electrolyte. Whole pile is cathodic and protected by hydrogen film and calcareous deposit due to local alkalinity.

Simplified mechanism of cathodic protection system.

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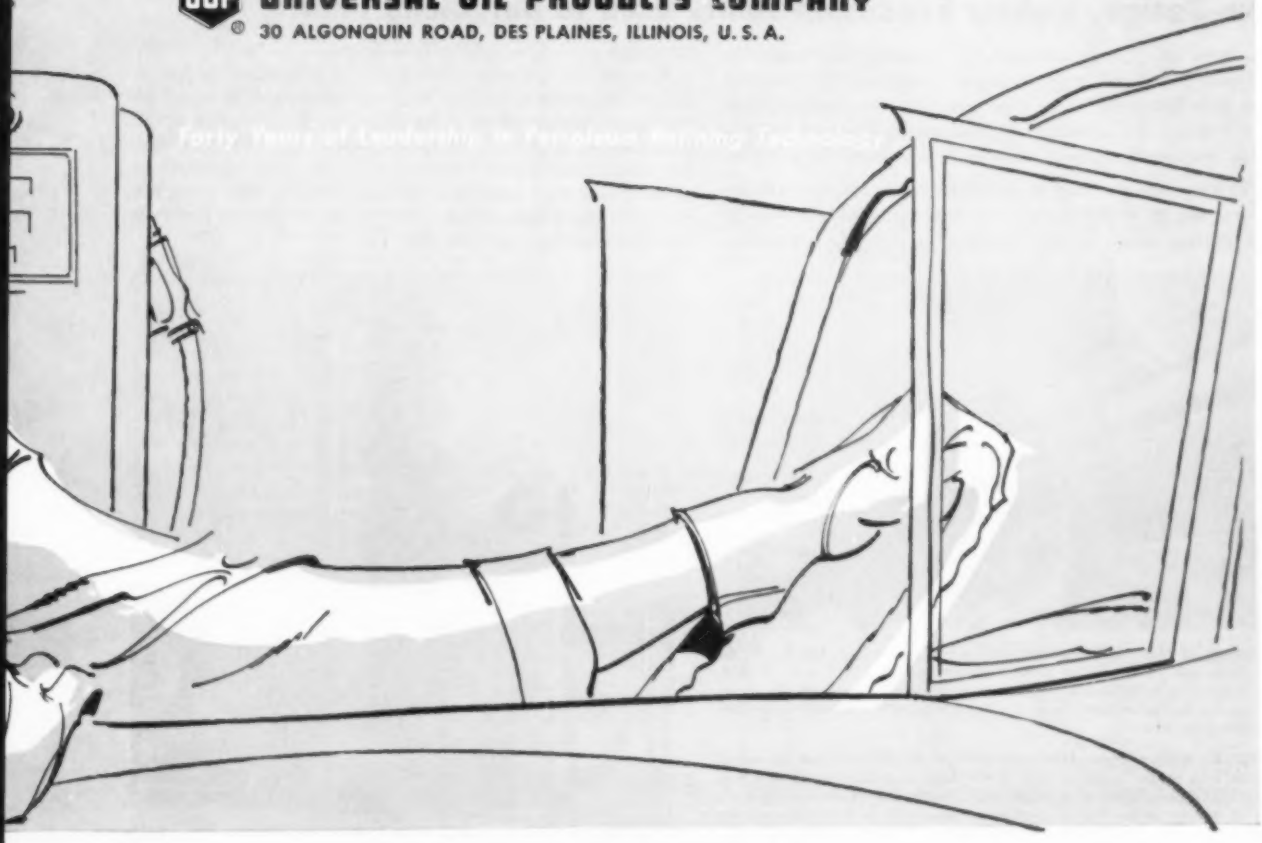

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The sea water intake flume at the refinery consists of three parallel lines of steel sheet piling, roughly in the shape of a "T." The upright forms the flume and roadway, 28 ft wide and extending about 780 ft towards the sea. The cross of the "T" forms the screen bays and forebays and is about 130 ft long.

Three groundbeds were installed, each fed from a transformer-rectifier. The external groundbed consists of 20 graphite anodes laid horizontally and is located in the foreshore north of the flume. The anodes, spaced at 10-ft intervals at an average burial depth of 3 ft 6 in., are contained in burlap sacks packed with carbonaceous backfill. The flume roadway groundbed consists of 18 graphite anodes mounted vertically and spaced along the roadway, contained in lengths of 18-in. steel pipe packed with carbonaceous backfill. The flume internal groundbed consists of 12 graphite anodes laid horizontally and spaced along the floor of the flume. Two concrete anchor blocks are cast on each of the anodes to stabilize them and minimize the possibility of rolling and consequently short-circuiting through contact with the piling. Another four anodes are mounted vertically in brackets, one in each of the two screen bays and one in each of the two forebays.

Inspection of the flume installation prior to completion showed that the pile coating was in poor condition; bare metal immersed in sea water was found to be heavily coated with marine growth. A drainage test was, therefore, carried out before the installation of the external groundbed to determine the current requirement. A d-c welding machine was used with an output of 165 amp, the current ultimately to be supplied by each of the transformer-rectifiers in the permanent installation. This current was applied continuously for three days, and the test revealed that protection was being afforded only to a limited area of the external surface of the sheet piling with no current spread to the seaward end of the structure.

A second drainage test using 500 amp was then carried out, and protection of the external surface was obtained. When the welding set was shut down, however, rapid depolarization occurred. To obtain satisfactory conditions a heavy current was applied to various sections of the structure in turn for several days to lay down a calcareous deposit on all bare submerged metal. In addition, the external groundbed was moved to the low-water mark to obtain better current distribution. Satisfactory protection was afforded when the permanent installation was finally commissioned. Total power input was then 7 kva and output totaled 500 amp, approximately 165 amp to each groundbed.

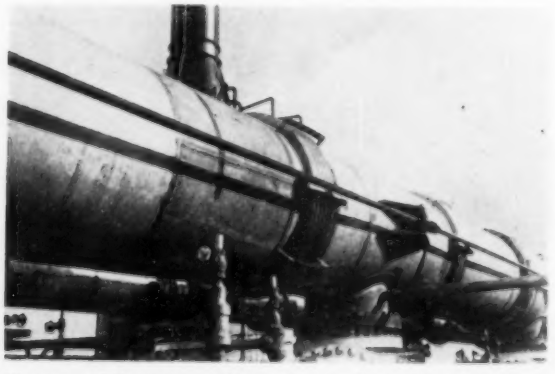
This protection system is designed to have a current density of 3.5 ma/sq ft over the entire immersed metal area of the jetty and flume. Its greatest advantage is its operation virtually without maintenance —apart from routine attention to rectifiers, cables and exposed paintwork. Operation is straightforward: Potential measurements are taken at three-month intervals, and should the metal-sea water potential fall below an absolute minimum, output from the transformer-rectifiers is stepped up accordingly. Tide conditions lead to variations in output but do not require any adjustments save for exceptional conditions during extra high tides. Since the system has been designed for continuous operation, transformer-rectifiers are kept in operation at all times, otherwise rapid depolarization would occur. ★ ★ ★

New-Design, Lighter Expansion Joints Used in Butadiene Plant

A "new look" in expansion joints went onstream recently at Texas Butadiene and Chemical Corporation's Lyondell plant near Houston, Texas (see p A-11). The spanking new plant is using 188 of Badger Manufacturing Company's new-design low pressure joints ranging in size from 14 to 72 in.

The joints are required to absorb thermal expansion of piping and vessels in the plant's five major process units — butane splitting, catalytic dehydrogenation, butylene separation, butadiene extraction, and sulfuric acid alkylation.

A radically different curvilinear corrugation design is claimed to result in a more uniform movement, is based on careful correlation between the shape, height, and pitch of the corrugations. A natural, all-curve shape is said to reduce flexing stresses and increase flexibility, giving better equalization of movement even without reinforcing rings. Longer cycle life is expected to result and the joints weigh 50 percent less than their conventional counterparts.



Close-up of the regeneration air line to the reactors. On this 48 in. line there are 14 expansion joints handling air at 1150 F and 35 psig. The expansion joints are fabricated from stainless steel with six corrugations each. The shipping rods shown were removed, of course, before insulating the line.

Catalytic dehydrogenation unit product is collected and quenched to 105 F in these towers, shown in the final stages of construction in this photograph. Three of the new-design expansion joints can be seen, one 48 in. unit at the top of each tower, and a 72 in. joint between the towers.

Puncture Plates

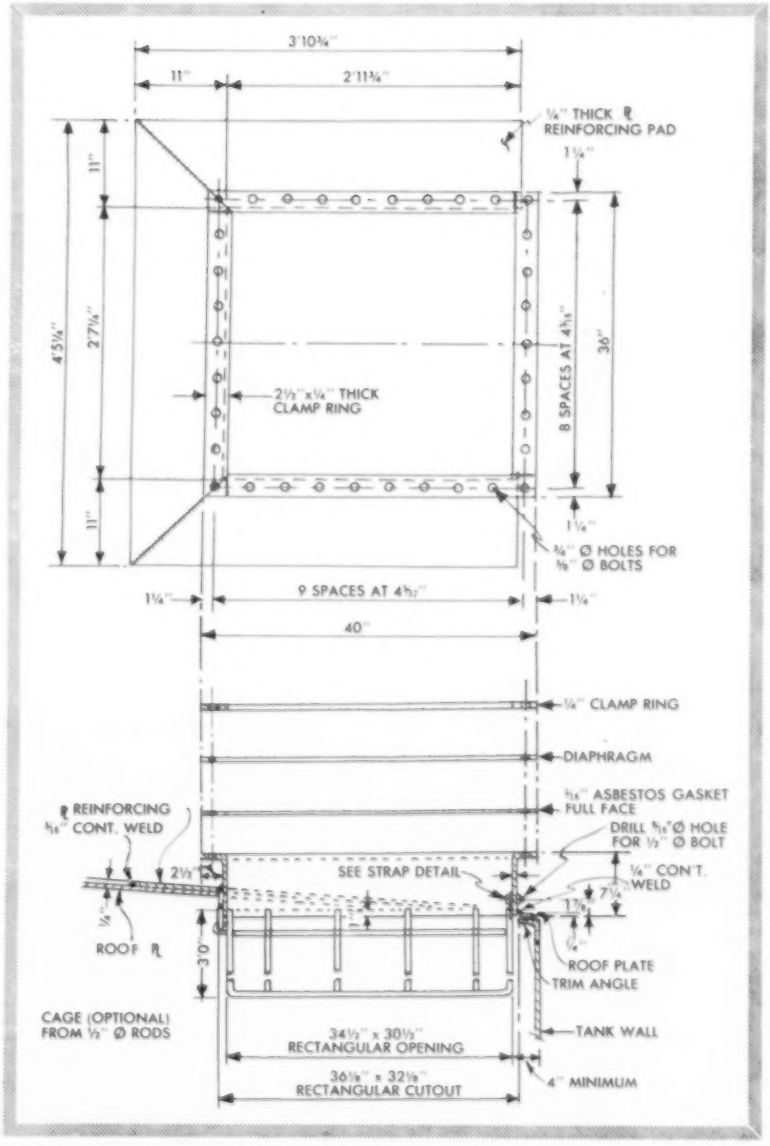
Speed Foam Application to Tanks

For fixed-roof tanks, puncture plates reduce investment, cut maintenance costs. Any type of foam tower may be used

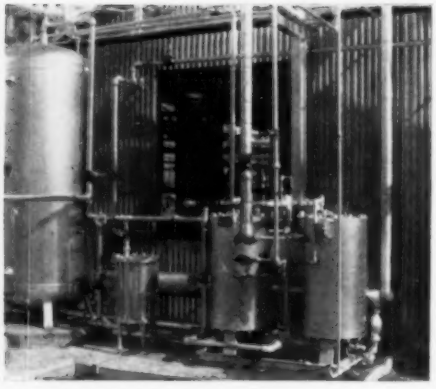
Louis Grossheim
Shell Oil Company

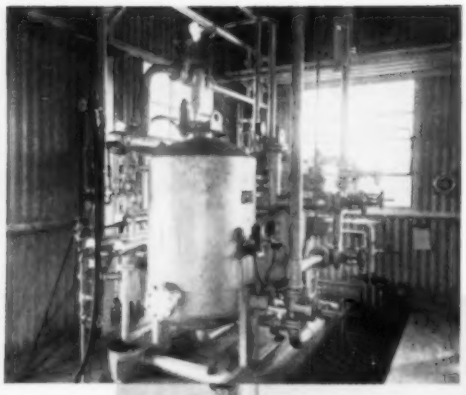
AN oil tank fire can be extinguished if foam is applied to the oil surface in sufficient quantities at adequate flow rates. With the exception of demolishing explosions of tanks, the loss of tanks by fire has generally been caused by *delay* in the application of foam after the initial ignition, a breakdown in the supply of extinguishing agents after application has started, damage to existing fire extinguishing facilities (such as fixed foam chambers), or inaccessibility to the oil surface because of roof or shell buckling. On this basis, our objectives in tank fire fighting equipment designs should be to develop the most positive means of foam delivery under all circumstances, in particular where tank roofs are partially damaged, and delivery in the shortest possible time, which is the main purpose of the *fixed tank roof* puncture plate installations.

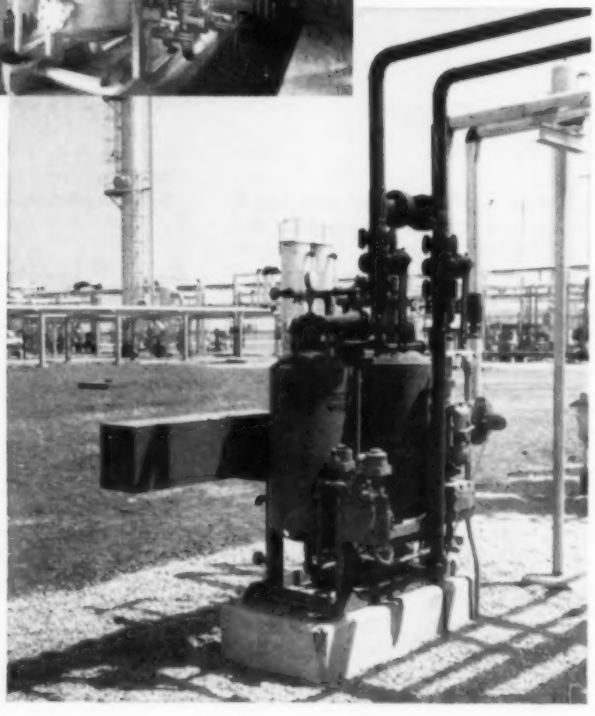
Purpose of tank roof puncture plates is simply to provide adequate roof openings for the admission of foam to the burning surface of oil inside the tank. The fixture is actually a revised roof manhole, and may replace or be used as such; this particular design is a 36-in. by 40-in. OD flange opening to accommodate a foam tower gooseneck penetration. Openings of various dimensions may be employed according to the desire or requirement of the particular location. A suitable guard rail with open end at the roof edge will act as a safeguard and a target for locating the foam tower gooseneck. As an added safety feature, a metal cage on hinges may be fitted to hang from the roof, just below the opening. A very durable glass fiber plastic cover of .04 to .05-in. thickness is used as the cover plate. Any other flexible or brittle corrosion resistant material of good durability (such as aluminum or lead) may be used. The pictures illustrate the simple process of rupture of the cover by the sharp edge of the



Tank opening for portable foam tower.







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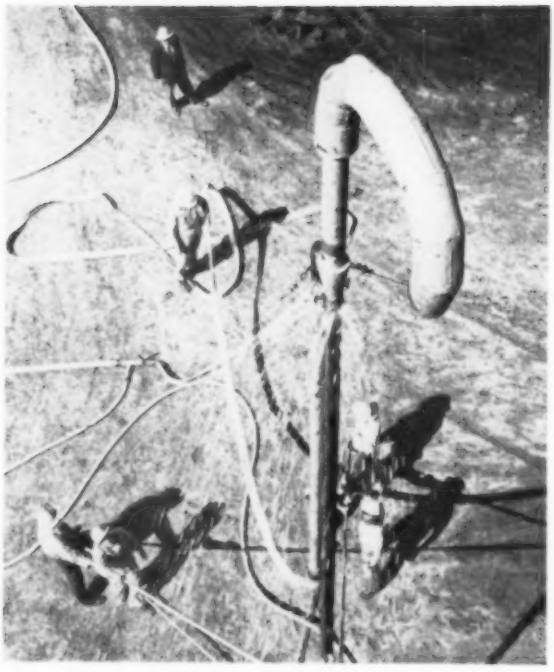
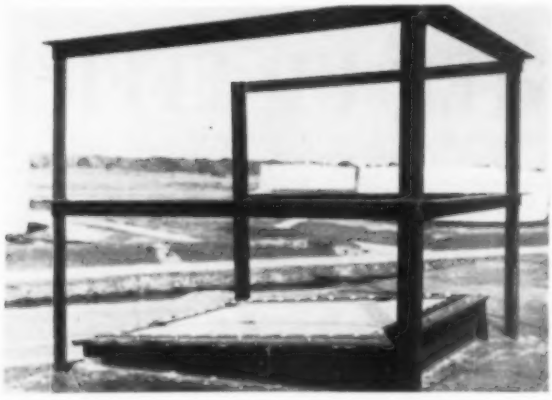
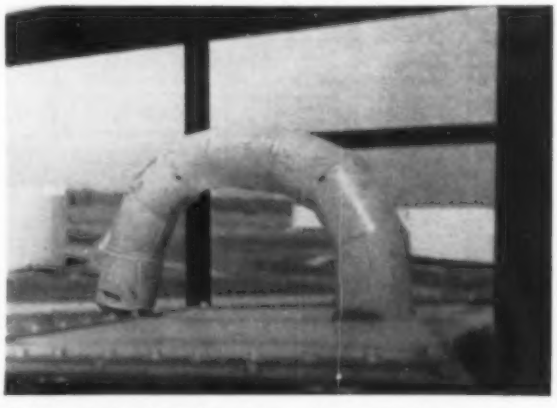


Hydraulic foam tower being raised into position above puncture plate on tank roof.



View of puncture plate installation on tank roof.

Gooseneck of hydraulic foam tower just prior to penetration of puncture plate cover.



Actual penetration of puncture plate cover by hydraulic foam tower gooseneck.

foam tower gooseneck, for injection of the foam solution. Design drawings offer details for installation and the use of the cage is an optional feature for additional safety purposes only; it has no function in the application of foam from the tower.

A minimum of two puncture plate openings is recommended for a small tank where one foam chamber would be indicated, and these should be placed in opposing positions on the tank roof in such a manner that one will be accessible at all times regardless of wind direction. On larger tanks the number of puncture plates and the locations should be determined on the basis of adequate openings for foam application and accessibility under any wind condition. It should be pointed out here that if larger openings are provided to accommodate more than one foam tower, the number of puncture plates may be reduced. This, of course, applies to the larger tanks.

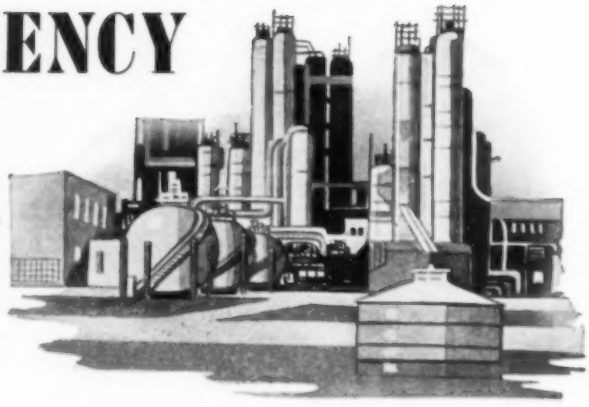
Some of the justifications for fixed tank roof puncture plates are:

1. **Accessibility.** One or more are accessible on a tank roof, with proper firewall conditions, for the use of any type foam tower regardless of the wind direction.

2. **Initial Cost.** It is not possible to give actual cost figures on the installation of these facilities due to the variation and fluctuation of labor and material costs. However, based on a 50-ft diameter tank, the cost of the illustrated puncture plate versus a foam chamber and line would be at least one-third less. The cost of the puncture plate could be further reduced to one-half or less by (1) eliminating the cage, and (2) modifying the design to eliminate the flange opening. Since the puncture plate material is flexible it may be possible to simply bolt it to an opening in the roof metal with gasket. This practice, however, will require further investigation. Obviously, for comparative purposes, the costs of foam chambers with larger and longer

STEP UP EFFICIENCY

Knock down Costs of Propane-Butane Condensers



You can boost efficiency—shave costs as well—when you specify Wolverine Trufin® Type S/T for new installations or for retubing propane-butane condensers.

On new jobs Trufin can slash total tube requirements and provide greater heat transfer. That's because integral-finned Trufin provides approximately two times more outside surface area (per lineal foot of tube) for condensing than does plain tube. Trufin cuts unit costs even more because less tubing means smaller shells, headers, baffles and less maintenance.

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Here is graphic proof of how Trufin increases throughput.

	"A" PLAIN TUBE HEAT EXCHANGER	"B" TRUFIN TYPE S/T HEAT EXCHANGER
SHELL SIZE O.D.	34 inch	34 inch
TUBE SPECIFICATION	⅞" O.D. 16 BWG Admiralty Plain Condenser Tubing	⅞" O.D. 16 BWG Admiralty Trufin Type S/T
TOTAL OUTSIDE AREA OF CONDENSER TUBING	3,460 Sq. Ft.	7,540 Sq. Ft.
TOTAL TUBE LENGTH	12,600 ft.	12,600 ft.
THROUGHPUT	81,050 lb/hr at 2000g/min water	127,000 lb/hr at 2000g/min water

Trufin is available in a wide range of alloys and sizes to meet your specific processing needs. For additional information and case histories of actual Trufin installations write for a copy of Wolverine's new book "Design and Cost Comparisons."

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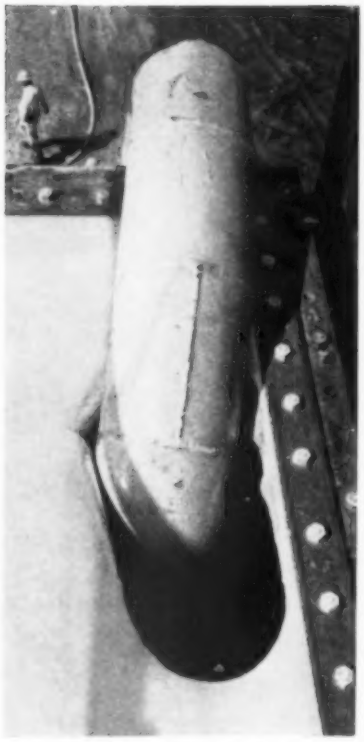

Gooseneck of hydraulic foam tower resting in place after penetration of puncture plate cover and ready for foam delivery.

lines runs for the big tanks would add considerably to the expense of foam chamber installations.

3. **Minimum Maintenance.** Only periodic visual inspections are necessary for this facility, and very minor maintenance expense is involved. Thus the cost of periodic inspections and maintenance of lines and other foam fixtures is eliminated.

4. **Other values** of the puncture plate openings are apparent. They may be used in the purging of gas by removing the covers and permitting natural ventilation from adequate bottom manway openings. In addition, the roof openings provide better ventilation and light penetration during cleaning activities inside the tank. This method of purging offers a considerable saving in the elimination of laying steam of air line runs for long distances from main headers to the tank for the operation of aspirators, or the use of air compressors with necessary piping for the same purpose. This was demonstrated on two occasions in our recent experience. We had two 250,000-bbl tanks, each with eight tank roof puncture plates and four 24-in. bottom shell manways, which had been in gasoline service. Each tank was emptied, then flushed with water through the suction line for one hour. All tank roof puncture covers and bottom manway lids were removed. The tank atmospheres were tested and registered extremely heavy gas concentrations. On the following morning (16 hours later) air tests were taken and the gas concentrations were nil.

There is a controversial value to the installation of tank roof puncture plates in instances where they are installed on tanks located in close proximity to one another. Where a tank is fitted with these openings and located near another burning tank, it is possible that the radiant heat and open flame may destroy the cover and ignite the tank; however, this risk must be considered as against heat pressurizing that same tank without openings and subjecting it to an explosion. Naturally, an area of this nature would have to be analyzed to determine which risk was indicated. No claim is made that the openings will act as a relief vent for tanks unless so designed, where such design is possible.

The proposed tank roof puncture plates are a pioneering venture in the direction of providing a more economical and positive foam application to burning tanks. While there is no history of experience in their use, the units appear to have merit. They are worthy of consideration for fixed-roof tank protection against fires. ★ ★ ★

The Author

Louis Grossheim is manager of the fire and safety department at Shell Oil Company's Houston, Texas, refinery. He has spent 36 years with Shell at various locations; practically the entire time engaged in fire and safety activities. Among his accomplishments is a patented foam tower used by fire departments in many refineries throughout the country.

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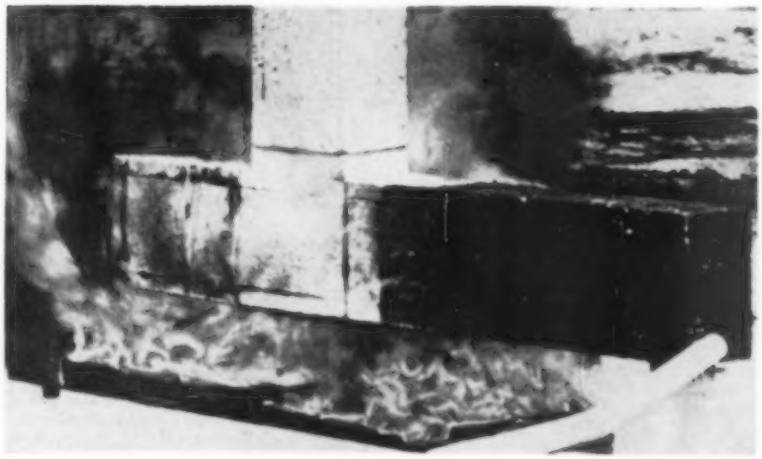

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II. SELECTING EQUIPMENT

L. Miscellaneous Equipment

Equipment for Lubricant Compounding Plants

C. J. Boner

Chief Research Chemist, Battenfeld Grease & Oil Corporation

COMPOUNDING plants, many of which are located on refinery grounds, compound and package lubricants. In some such plants specialty items such as polishes, cleaners, etc. may also be handled. In a number of cases the output is confined to oils only.

This arrangement permits economy in supervision and shipping. For example, mixed cars of barrels and package goods can be loaded at one point. Also, much of the laboratory control of such a plant is often taken care of by the works laboratory.

Since some of the base oils will be common to both lubricating oils and greases, less duplication of pumps and pipe lines is necessary if compounding operations are combined.

Further, such plants, if on refinery property, can take advantage of the power facilities of a large installation which should point to economy.

The lubricants may consist of either fluid or plastic products, the former being, for the most part, lubricating oil and gear compounds, and the latter lubricating greases. In most cases the fluid products are prepared by blending, although some unblended lubricating oils also may be packaged. The lubricating greases require considerably more processing than do the fluids, often in several steps, hence more equipment and labor is required for a given throughput of such products than for fluid types. However, the normal sales of an oil company will probably have a ratio of about one pound of lubricating grease to a gallon (seven and a half pounds) of oil, hence the latter products account for much the largest proportion of the tonnage of a compounding plant. Gear compounds may account for even less volume than the lubricating grease unless the plant enjoys the initial fill business of automobile and truck companies.

After observations about the plant in general, equipment required for processing fluid lubricants will be described in one article. In a subsequent publication, the apparatus necessary to handle plastic products will be detailed.

It should be emphasized that any specific pieces of equipment mentioned are not the only devices applicable to the processes in question. The desire is to give a view of what may be used with the thought that this will furnish ideas for adaption of still different equipment for similar service.

Unit Operations

The operations carried out in a compounding plant consist of both simple mixing of two or several ingredients or actual chemical reactions followed by a variation of heating, mixing, cooling, filtering, milling, and deaerating. Whatever the compounding procedures, these steps are followed by packaging, storing, and shipping.

In the above operations the raw materials will consist largely of fluids with a small proportion of solids. The finished products are fluids, semi-fluids, or plastics.

Location of Compounding Plant

In considering the specific location of a compounding plant, the situation of already existing lubricating oil manufacturing and storage facilities may be the determining factor. Transportation facilities and shipping charges, whether by rail, trucks, or water, will be of equal importance, however. While some lubricants ship in tank cars and tank trucks, there seems little likelihood of movement by pipe lines for any distance.

General Layout of Compounding Plant

The size and floor space of the building housing the compounding equipment will depend not only upon the tonnage which will be handled, but also on the variety of items to be manufactured and packaged and the storage space demand. Geographical location may also be a factor in housing, in that some storage tanks for both mineral oils and fats will be located inside the operating building if extreme cold weather prevails at some portion of the year (see Fig. 1).

The ideal flow of materials, containers, and filled packages would be from incoming cars or trucks, through the plant, and immediately back into outgoing carriers. Since this desired situation is seldom attained, it will be consid-

FIG. 1. Storage tanks inside compounding plant buildings. (British American Oil Company.)

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3 Rental with Option to Purchase

The rental plan is similar in all general respects as to instructions, supervision and materials furnished in plans No. 1 and No. 2. After acceptance requirements have been fulfilled, the pre-determined annual rental fee is payable according to the payment option selected by the customer.

After the plant has been operated for three years on the rental basis, the customer has the option of purchasing the equipment for a pre-determined price. (This price is reduced after each year's rental.) After a unit has been used on a rental basis for seven years, the annual rental fee is reduced about 50%.

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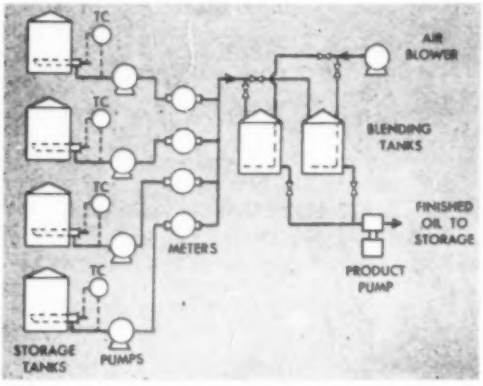

FIG. 2. Flow plan of batch blending of lubricating oils. (Petroleum Processing.)

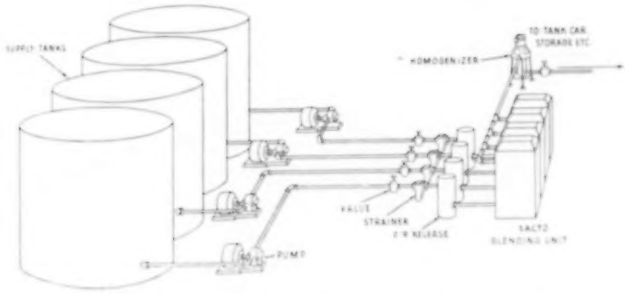

FIG. 3. Flow plan of continuous automatic blending. (Bowser, Inc.)

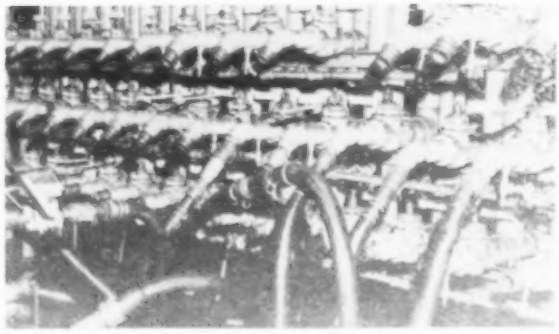

FIG. 4. Manifold in oil blending plant. (Phillips Petroleum Company.)

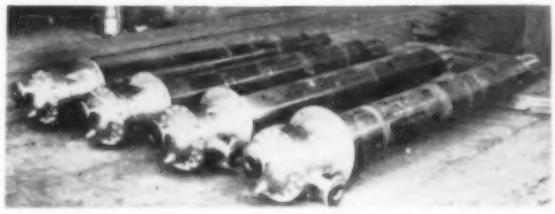

FIG. 5. Tube bundles used for heating oil. (Struthers-Wells Corporation.)

ered that space and equipment must be provided for storage of both incoming and outgoing materials and products.

While there is a possibility that empty containers will be manufactured by the firm operating the compounding plant, this practice is not too common and hence will not be considered in connection with these articles.

It is possible to operate a compounding plant from one level only, but a building of two or three floors is more desirable for at least a portion of the plant. This is particularly true of the part used for the manufacture of lubricating grease, therefore at least a two-floor building will be presumed for this purpose.

Blending Fluid Lubricants

Fig. 2 and 3 show the respective flow charts for batch blending and for continuous automatic blending of lubricatings oils. The same plans can be employed where the final product is to be a gear compound or an entirely synthetic fluid.

Such blending can be so integrated that the operation will use conveyers common to those also employed to handle empty and filled packages of lubricating grease or an entirely separate layout can be provided for the two purposes.

Equipment for Batch Blending of Oils

A storage tank is suitable for blending of batches of lubricating oil. This may be a vertical or horizontal vessel but the former is most often used. While a capacity of 5000 to 50,000 gal is most common, blending tanks of any size can be used. An open kettle with some means of agitation of the contents will also serve for small lots of oils.

A tank blender should be equipped with a steam coil. For small tanks, a $\frac{3}{4}$-in. coil is satisfactory and large vessels seldom require coils larger than 2-in. diameter. Since high temperatures are not necessary or even desirable, steam of 30 psi should suffice for heating.

If air is to be used for mixing, a 1 to $1\frac{1}{2}$-in. air coil, having 1/16-in. holes, spaced about 1 to 2 in. apart will provide agitation for the blender. Since the function of the air is not only to mix the oil but also to remove any traces of moisture, the air should be dried and preferably heated to about 150F.

Charging a Batch Blender

The equipment for charging the oil blending tank may vary. One arrangement consists of having a single pump to which the suction lines from various oil storage tanks are connected. The same pump could even be used for discharging the blender. In case a large number of storage tanks are involved, a manifold, such as that shown in Fig. 4, will be necessary. Since a number of combinations of inlet and discharge connections may be required, flexible hose permits rapid connection. This may be flexible metal or preferably oil resistant rubber hose.

Pumps can be of any type desired, that is centrifugal, gear, or reciprocating, driven by electricity, air, or steam. In most cases they are electrically driven centrifugals. There will be less possibility of contamination if separate pumps and lines are provided for each component of the blend. This arrangement may also speed up the charging of the blender since more than one fraction can be added simultaneously.

The oils should be handled at about 120 to 150F so as to expedite movement and mixing. The most satisfactory means of heating is by use of suction heaters, such as those shown in Fig. 5. These consist of tube-bundles around which the outgoing oil passes and thus the entire tank contents need not be heated. Naturally, a temperature controller should be included in the steam line feeding the suction heater. Calculations can be made before installation so that the desired heating surface will be obtained. The variables for such calculations consist of gpm to be delivered, steam pressure, and the ambient and delivery temperatures.

No mention has been made of pipe sizes which will vary depending upon the volume of material to be handled. Seldom will the pipe be less than $1\frac{1}{2}$ in. ID and more often 2 or 3 in. ID. The type and number of valves will

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vary somewhat with custom of the company. It is sometimes desirable to supplement air mixing by circulating the mixture in a blending tank. For this purpose a line from the discharge pump can enter the top of the tank at a point opposite the tank outlet. In any event it is wise to tap the outlet line and install a ¼-in. pipe for a sampling cock.

Gaging a Batch Blender

While the blending tank contents can be gaged by means of a steel tape with a bob (see Fig. 10 in ASTM Method D 1085-52T) or even by means of a gage stick (see Fig. 11 in above Method), it is much better to have some visual means of gaging that will not necessitate going to the top of the tank.

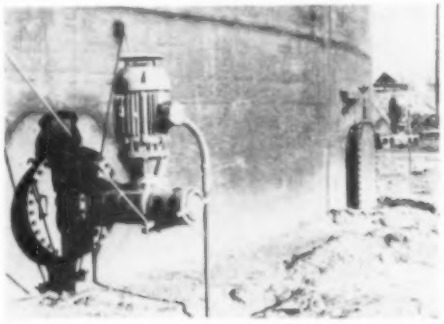

FIG. 6. Side-entering mixers on blending tanks. (Mixing Equipment Company.)

A simple and convenient arrangement consists of a free float attached to a cable, chain, or tape. The float may be an airtight sphere 8 of 10 in. in diameter with an eyelet soldered on for attachment to the cable. Another form of float has the form of a cylinder 4 or 6 in. in height and 10 to 12 in. in diameter, likewise with an eyelet attachment. A flexible metal cable a quarter inch or less in diameter can be attached to the float. Pulleys of 3 to 6 in. in diameter are provided for the cable to run on. One of these pulleys should be fastened to the top of the tank far enough from the side so that the float will be free from contact with the side. The other pulley is located so that the cable will drop free of the outer side of the tank. On the free end of the cable will be a counterweight, perhaps in triangular form with the point downward. The flat side will then pass graduations either marked on the side of the tank or on a gage pole secured to the side of the tank. Fig. 1 shows such a scale and a counterweight consisting of a metal bar bent into a five-sided flat piece. Free movement of the float and the indicator are necessary. The scale may be made so that the graduations are in feet and inches or the gallonage corresponding to the depth can be stenciled on the tank also. It should be kept in mind that if tanks lack a solid base, the bottom may be flexible and in such a case there is a chance for error in gaging.

Liquid level gages are available that will indicate the depth of tank contents at a distance and can thus be installed adjacent to pump controls. It is also possible to provide for recording of tank levels on a clock dial but this is seldom done in plants employing batch blending. Rather than go to this expense, it is better to provide meters for gaging.

Metering Blender Components

The accuracy of batch blending will be considerably improved if the oils are measured through meters. A single meter will suffice but individual meters for each type of oil will permit quicker charging and less contamination.

Since the oils will normally be pumped at a given temperature, meters calibrated for the one delivery temperature can be employed. Therefore the added cost of automatic temperature compensating devices is hardly justified.

Most oil meters provide a strainer ahead of the measuring mechanism but if this is not provided, one should be installed. Streams of oil frequently contain entrained air which leads to an error in meter readings. If such is the case, an air release is advisable ahead of the meters.

If individual meters are provided for each component, each meter can be set to deliver the gallonage required. In addition it is good practice to provide still another meter through which the finished batch is pumped off. This then acts as a check for the total gallonage shown by the individual meters.

Whatever the arrangement of gaging or metering it is well to have remote control of the pumps. This can be through solenoid valves actuated by either the meters or by push buttons. Further, if the pumps are of a type that might be damaged by shutting a valve while power is on a pressure relief valve, an excess pressure governor, or a pressure switch should be provided.

Power Mixing

Power mixers can replace air for blending lubricating oils. Thus a side-entering mixer such as that shown in Fig. 6 is used for this purpose. The size of mixer and motor to drive the same will vary with both the gallonage to be mixed, the viscosity of the oil, and the time consumed in blending. Where an oil of a viscosity of 300 to 400 SUS at 150F is to be mixed, Table I indicates the size drive suggested. In practice a period of two hours is most desirable for blending. It is customary to start the mixer when about half the charge is in the blending tank and thus have

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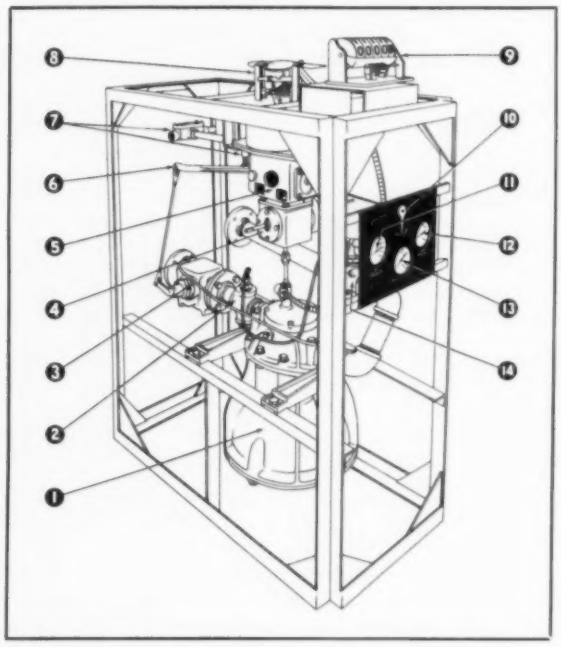

FIG. 7. "Xacto Unit."

(1) Xacto meter (2) Thermometer well (3) Inlet control valve (4) Differential (5) Control nut (6) Valve control arm (7) Pump control circuit and switch (8) Selector (9) Indicating and totalizing dial (10) Flow indicator (11) Inlet pressure gage (12) Discharge pressure gage (13) Dial thermometer (14) Discharge check valve. (Bowser, Inc.)

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1. Lowy, Lawrence, Petroleum Processing, 10, 357-360 (1955).
2. Lueth, Paul F., Jr., Inst. Spokesman, 16, No. 1, 18-23 (1952).

A following article will deal with equipment for use in the manufacture of lubricating greases.

TABLE 1. Suggested Horsepower for Side Entering Mixers

Blending time	½ hr	2 hr	4 hr	8 hr
Tank volume — 5,000 gal	5 hp	2 hp	1 hp	—
50,000 gal	50 hp*	15 hp	7½ hp	5 hp

*Two — 25 hp units

the mixing complete about ½ hour after all of the oil and additives are charged.

Continuous Automatic Blending

Continuous automatic blending of lubricating oils is accomplished by syncronizing a series of pumps and/or meters so that desired proportions of ingredients are fed to a blender or homogenizer where the mixing is completed. This blender is of rather small capacity, perhaps holding a barrel of fluid, therefore the entire system contains a minimum of fluid at any one time.

Several companies offer systems to accomplish the above purpose and most compounders rely on such firms rather than design their own blending equipment. Details of some of the most successful of such systems will be described.

The equipment to be considered first is capable of blending two to six or eight different components. Later, suggestions will be made for methods and equipment to blend one oil and one additive only.

While the use of pumps, for delivery to blenders, is mentioned, it should be kept in mind that gravity can be adapted if sufficient head is available.

Bowser Blending System

A multiple of the units shown in Fig. 7 are employed for lubricating oil blending. The number of units installed depends upon the maximum number of components in the blends that are to be compounded. Likewise, the size of the meters can vary. Normally the No. 1 meter is the one with the greatest capacity.

Location of the various parts and mechanisms in each "Bowser" unit are evident from the tabulation of the numbered parts in Fig. 7. Such an arrangement is further detailed in Fig. 8, where connections between three units are shown.

The meter used in the Bowser system is shown in a cutaway view in Fig. 9. This consists of a positive displacement, piston type meter, called the "Xacto Meter." It is furnished in sizes up to 3 in. diameter connections. The flow rates of a ¾-in. meter are from 0.9 to 15 gpm and of a 3 in. size are 10 to 250 gpm. The working parts of these meters can be furnished in various metals so as to reduce the possibility of corrosion.

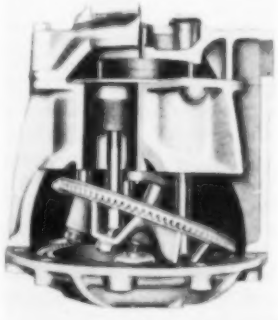

FIG. 9. Cutaway view of "Xacto" meter.

The selectors at the top of each metering unit are shown in Fig. 10 and consist of a means of setting a train of gears so that the speed of the driving shaft and in turn the delivery of the meter will be varied as desired. The meters are actuated by the pressures due to the supply pumps for each individual component.

The drives also act as a means of insuring correct proportioning and, when there is a deviation in supply, of cutting off the system. Referring to Fig. 8, in which three connected meters are shown, the total speed of the lower shaft, at the end where a drive chain is shown, is the combined speed of the three meter shafts. Differential gearing, adjusted by means of the selectors (see Fig. 10) so that the speed of each meter shaft is proportional to the amount of the component passing through the respective meter, insures that the

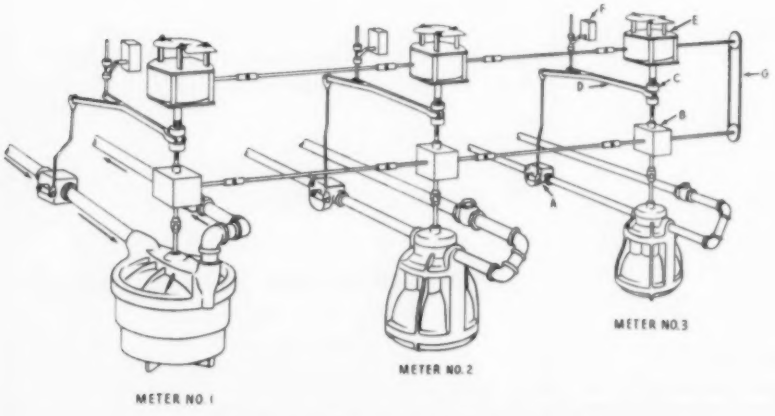

FIG. 8. Assembly of "Xacto Units." (Bowser, Inc.)

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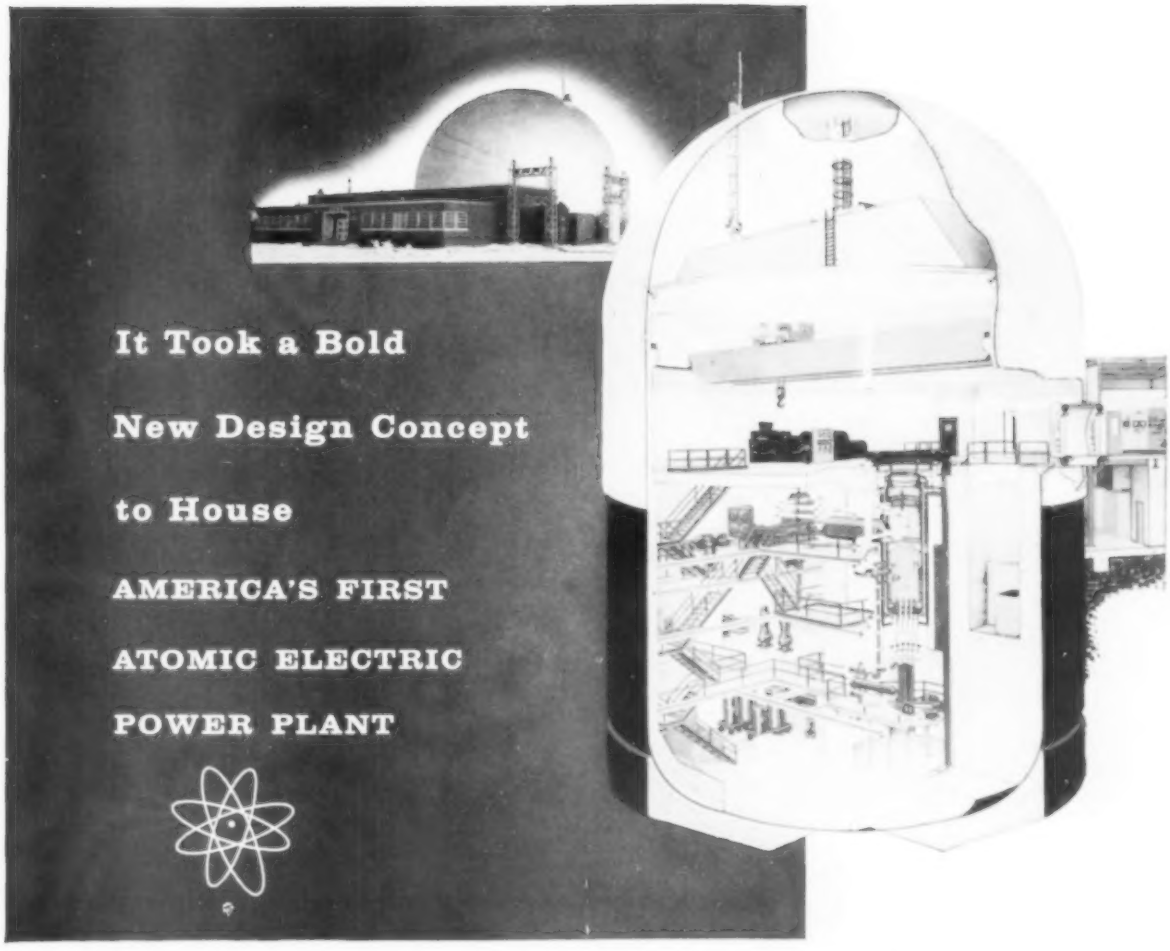

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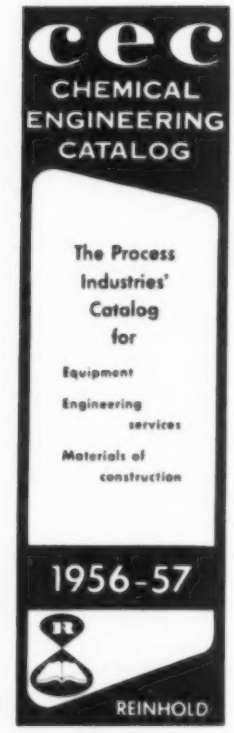

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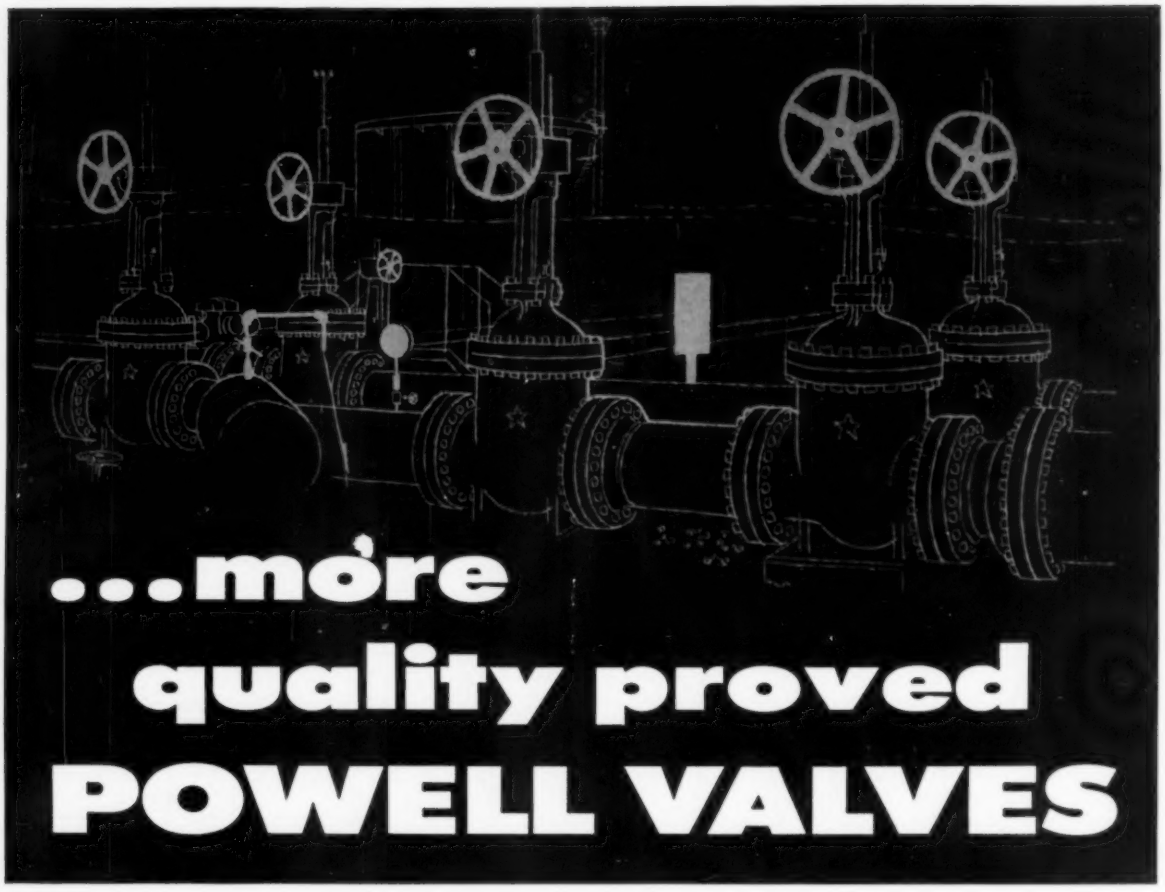

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Fig. 2467—Small Stainless Steel Gate Valve for 300 Pounds W.P. Outside screw stem and bolted yoke.

Fig. 86190—Steel "LPG" Globe Valve for 400 W.O.G. For services that demand the use of Steel Valves.

Fig. 1303—1500-Pound Steel Gate Valve with bolted flanged bonnet and outside screw stem and yoke.

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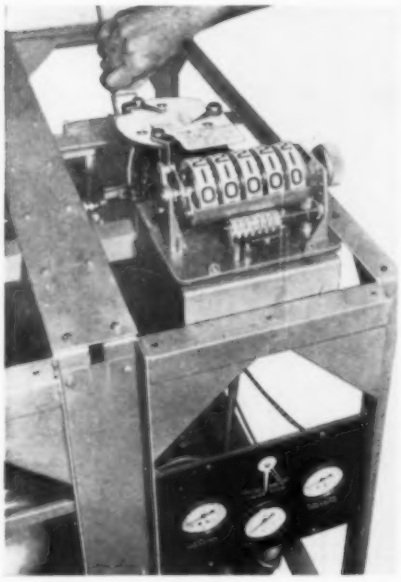

FIG. 10. Selector by which percentages are set on Bowser blender. (Bowser, Inc.)

FIG. 11. Installation of Bowser blending system. (Bowser, Inc.)

total increments of the three meter shafts make up 100 per cent.

If the meter shaft should vary in speed and thus throughput, the selector shaft causes the control nut C (see Fig. 8) to move on a threaded shaft and thus move the control lever D which in turn controls the valve A in the delivery line. If the fluid supply should completely cease, further motion of the arm D would operate switch F and stop all of the supply pumps.

The schematic view of a layout for a "Bowser" Blending Unit, as shown in Fig. 3, (Part 1) indicates the accessories recommended in the supply lines for oils. To insure that the flow into a meter is not greater than its maximum capacity, a flow control valve is recommended in the discharge line from the supply pumps. This should be followed by a strainer to remove dirt and by an air release. Only by such an air release can accuracy of metering be assured.

While a certain amount of mixing results as the streams of oil and additives from various units pass through the discharge manifold, the Bowser blending system provides for a motor driven homogenizer so that thorough blending will be obtained.

The capacity of such a system will vary from 5 to 500 gpm depending upon the size and number of units. A view of a blending system in which five Bowser units are used is shown in Fig. 11. This indicates the compactness of such a blending system for lubricating oils.

Cornell Proportioning Units

A typical diagram of a "Cornell" continuous oil blending layout is shown in Fig. 12 and a typical installation in

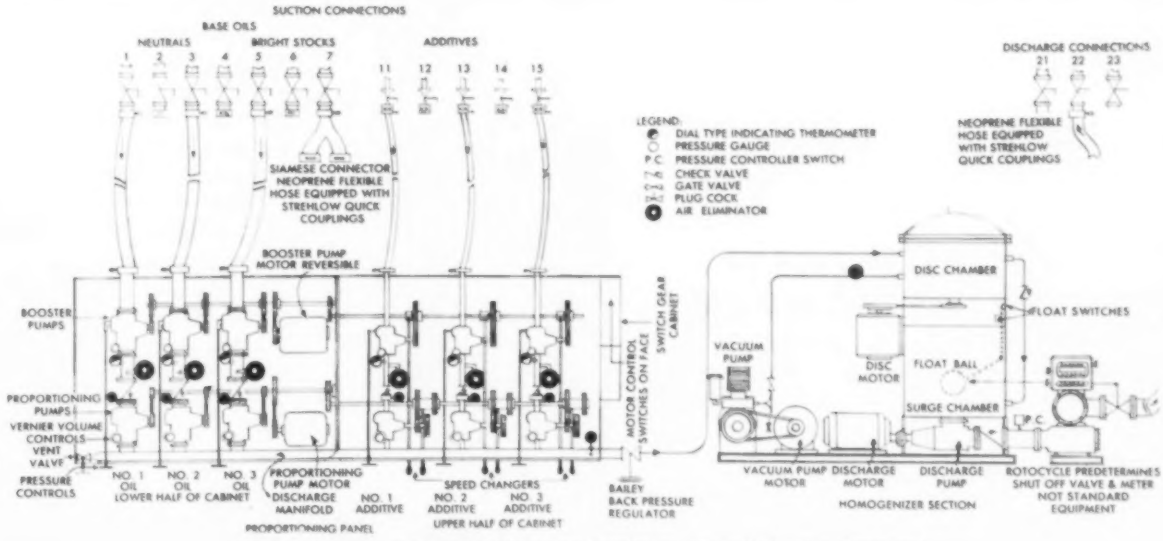

FIG. 12. Diagram of Cornell Oil Blending Installation. (Cornell Machine Company.)

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- Hydrofluoric Acid Aqueous
- Hydrofluosilicic Acid
- Lead Fluoborate
- Metallic Fluoborates
- Potassium Bifluoride
- Potassium Chromium Fluoride
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- Potassium Titanium Fluoride
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- Zinc Fluoride

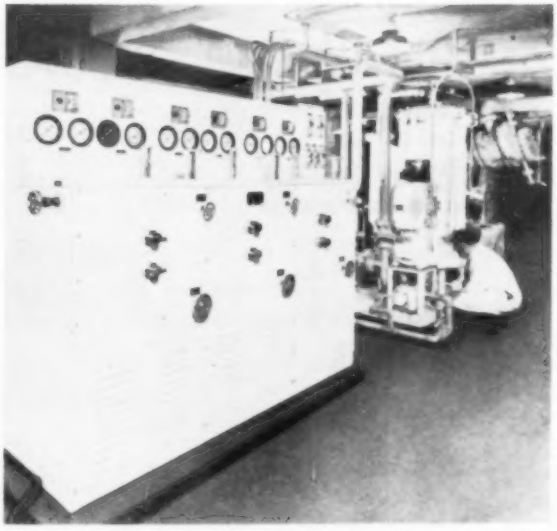

FIG. 13. Cornell blending system at Canadian Oils, Ltd. (Canadian Oils and Cornell Machine Company.)

Fig. 13. The diagram provides for three (or fewer) oil base stocks and three (or fewer) additives to be blended. Since various blends will require different oil stocks, a manifold, similar to that shown in Fig. 4, permits changing of the base stocks delivered to the three booster pumps.

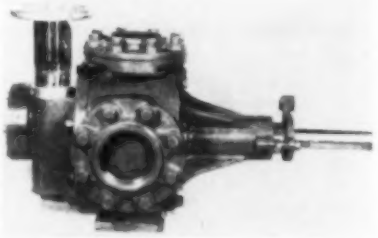

FIG. 14. Proportioning pump with vernier volume control setting device. (Cornell Machine Company.)

Connections in the manifold room are made with neoprene or some other oil resistant rubber hose or a flexible metal hose. For ease in hooking up quick connecting couplings, such as "Strehlow" couplings are provided.

The booster pumps are pressure controlled to deliver the oil at a constant pressure of 20 psig to the suction of the porportioning pumps. An air eliminator is provided in the connecting piping between the two pumps.

The proportioning pumps are calibrated and equipped with a vernier volume control setting device, see Fig. 14. The proper percentage of each component of the blend is determined and the volume set on each proportioning pump is adjusted accordingly. A correction factor is applied to each setting to allow for the temperature at which the oil stream is delivered so that all measurements are at 60F basis.

The pressure on the discharge manifold to which the proportioning pumps deliver is held at 20 psig by means of a back-pressure regulating Bailey Valve. Since the suction pressure and the discharge pressure of the proportioning pumps are both 20 psig, there is no pressure loss across the pump and the motor driving it supplies only rotational energy. Thus, the pump is energized meter and hence, capable of great accuracy.

Upon leaving the proportioning pumps the streams of components of the blend mingle in a pipe leading to the Cornell Homogenizer. If this piece of equipment is to be used for dehydration as well as for blending and deaeration, a heat exchanger is provided so that the oil will have a temperature of about 150F. The Cornell Homogenizer consists of a hemispherical disc rotating at 900 to 1800 rpm and the field being processed is introduced at the center of the top face and proceeds outwardly under centrifugal force in a thin film. A scoop tube at the outer edge of the disc picks up the fluid and discharges it to a surge tank chamber below the disc. The rotating disc and upper chamber are subjected to a vacuum of about 27 to 28 in. of mercury so that any entrained air and most of the moisture is removed.

The surge chamber has a capacity of about one barrel and contains a ball float connected to two float switches. The discharge pump is connected to the bottom of the surge chamber. This is a Yale and Towne volume controlled pump and when the blended oil is being discharged at the set rate the system is in equilibrium and the oil level in the surge chamber remains constant.

If a valve should be closed in the discharge line causing the pressure in the line to increase the pressure controller will shut off the discharge pump motor. This will result in

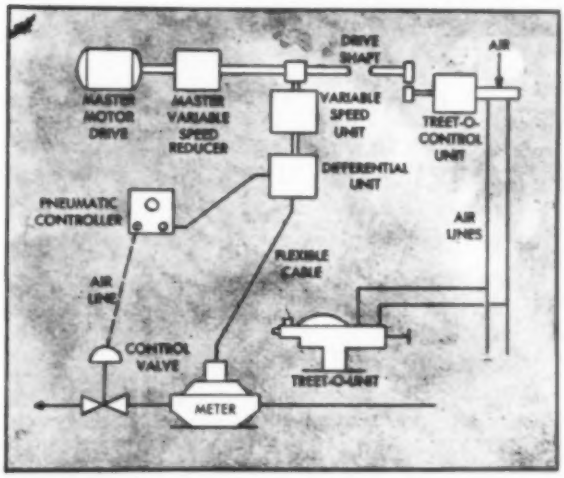

FIG. 15. Flow control system for component and additive panels. (Proportioneers.)

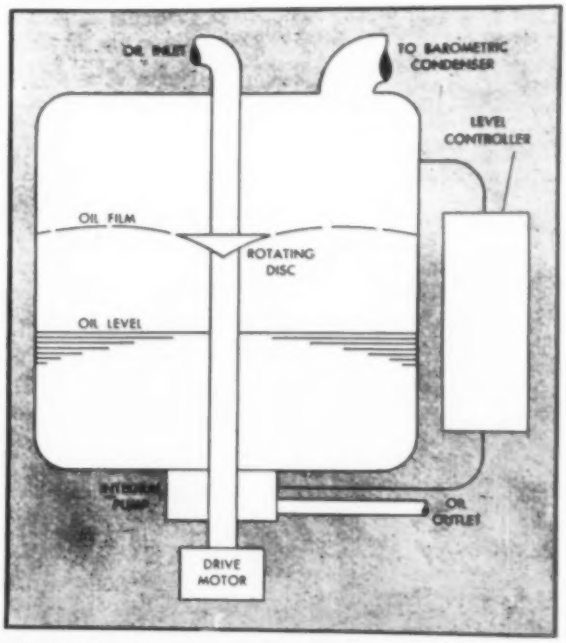

FIG. 16. Internal arrangements and auxiliaries for flash evaporator. (Proportioneers.)

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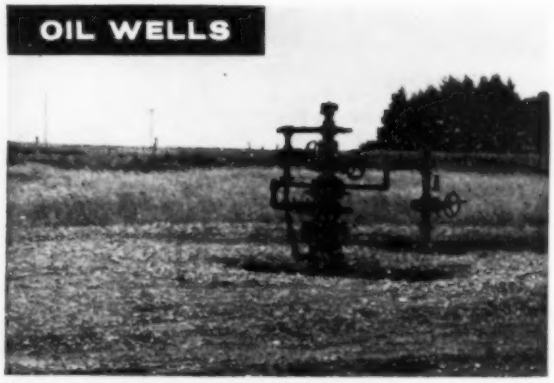

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a rise in the oil level in the surge chamber which if it continues will raise the float and actuate the float switch which in turn will shut off the proportioning pump motor. When the valve in the discharge line is opened, the decrease in pressure will first cause the discharge pump motor to start and then as the oil level drops in the surge chamber the float switch will cause the proportioning pump to start so that blending is resumed.

If any cause, for example, the presence of air in the air eliminator, should result in stoppage of the proportioning pump, the flow of oil into the surge chamber would cease. Since the discharge pump would still operate, the level of the oil in the chamber would drop and cause the ball float to drop whereby another switch would be actuated to shut off the discharge pump. This action would be reversed when the oil level rises due to starting of the proportioning pump.

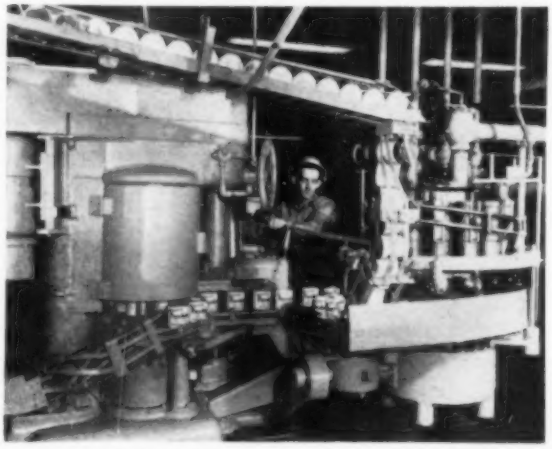

FIG. 17. Oil canning machine, showing a 14-pocket Pfaudler filler, and an American Can Company closing machine.

FIG. 18. Filling machine for one-gallon cans. (Standard of California.)

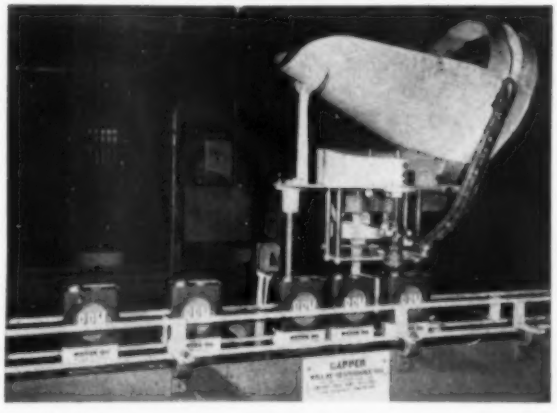

FIG. 19. Capping machine for one-gallon cans. (Standard of California.)

Proportioneers Oil Blending Unit

Proportioneers, Inc., offers a continuous automatic blending system the flow control system for which is shown in Fig. 15. It will be noted that high pressure air as well as electricity are necessary for the operation of such a unit.

Each oil blender consists of a master panel, several component panels to control the various oils used, and additive panels. Each oil panel consists of a pump, an air eliminator, a pneumatic controller, a positive displacement meter, a control valve, and a three way re-cycle valve.

The master panel controls a synchronous drive motor and an infinitely variable speed reduction unit. The output shaft from the latter unit drives one shaft of a differential in each component panel through an infinitely variable integrator. The second shaft of the differential on each component panel is driven by the component meter. Consequently, when the meter is driving one shaft of the differential at exactly the same rate as the other input shaft is being driven by the master panel, there is no motion from the third shaft of the differential and the component oil is flowing at exactly the correct rate. If the rate of rotation of the two input shafts is different, however, some rotation will be produced in the third shaft. Such rotation will cause the pneumatic controller to change the air pressure on the flow control valve and bring the flow through the meter back to the proper control point.

The additives, which are required in much smaller concentrations than the various oil fractions, are added by what is termed a "Treet-O-Unit." This is essentially an air actuated simplex reciprocating metering pump. The stroke of each such pump can be adjusted in length to a hundredth of an inch. The drive from the master panel then determines the number of strokes per minute of each "Treet-O-Unit."

These blenders vary from those previously described, in that provision is made for recycling both before starting to blend and also if any one component pump loses suction or the flow of any one component varies more than a predetermined amount. Also, when the predetermined number of gallons desired for any one mixture has been blended, the unit is automatically thrown on recycle.

Before discharging, the combined stream of oil from all of the panels passes to a flash evaporator, see Fig. 16, which removes most of the moisture from the oil blend. This evaporator is also a mixer and both functions are accomplished as the incoming oil passes as a thin film over a rotating disc. The closed chamber containing this disc is subjected to vacuum by means of a steam jet asperator.

Proportioneers make provision for cleaning the oil from all panels when a blend is completed. For this purpose, high pressure air is automatically admitted to the air eliminator chamber. All of the oil remaining in meters, lines, valves, pumps, and suction manifolds is then blown back to the respective storage tanks. This of course results in very little contamination in the next blend.

Equipment for Additive Introduction Only

Where a single additive is to be introduced in a lubricating oil and no further blending is desired, several arrangements of equipment are possible. It should be kept in mind that additives are often expensive and also may be used in small proportions. For both reasons it is some-

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FIG. 20. Automatic barrel filler. (OPW Corporation.)

times best to make up a stock solution of the additive in oil and use this in the blending operation.

One of the most positive means for injection mixing is to use an injection pump driven by a motor that is controlled by an interlocking switch connected to that of the oil line pump motor. The injection pumps are generally adjustable over a 10 to 1 capacity range and have capacities varying from 5 cc per min to 40 gpm.

No pump is required if the additive is introduced by the pressure of a closed tank. In this case a flow indicator, such as a Rotometer, can be included in the additive line and a calibrated point arrived at by checking the consumption of the additive over a given period with the gallonage of oil pumped.

Lowy[1] states that flow porportional injection methods are becoming preferred for introduction of additives in a stream of liquid due to greater accuracy. Five such systems are described and sketched by this author. To accomplish such injections, solenoids are actuated by meters in the product line so that an additive pump operates at intervals depending upon the flow in the product lines.

Benefits of Continuous Automatic Blending

Continuous automatic blending of fluid lubricants decreases the labor and supervision of such an operation and also provides greater accuracy than does batch blending. There is considerable saving in space requirements with a continuous blending setup.

Therefore, with a variety of satisfactory equipment available, all new installations and many old ones depend upon continuous automatic blending of lubricating oils and gear compounds. As an example of the widespread use, one firm has recently furnished installations for Australia, India, and South Africa.

Packaging of Fluid Lubricants

Fluid lubricants, as well as some other items handled by compounding plants, may be packaged in sizes of four ounces and intermediate sized containers up to full barrels. Satisfactory equipment to fill and seal such packages is provided by a number of firms (see Fig. 17, 18, and 19) and, since the mechanical details are quite intricate, no great description of the fillers will be given.

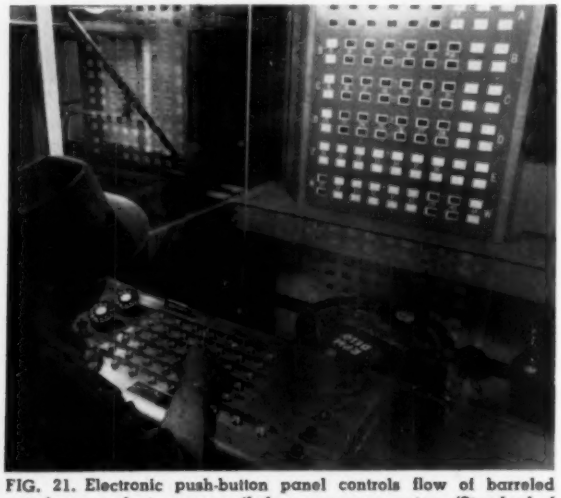

FIG. 21. Electronic push-button panel controls flow of barreled petroleum products over a mile-long conveyor system. (Standard of California.)

FIG. 22. Storage of packed and packaged products. (Standard of California.)

In general, can fillers depend upon two general principles. In one case a series of chambers are filled as a carrier rotates and the measured contents is then discharged into the container. Other equipment depends upon a spout which enters a can and raises as the can is filled until a cutoff of the liquid results.

Automatic barrel fillers may be similar to that shown in Fig. 20, where a float actuates a cutoff when the proper depth of fluid is reached.

Handling and Shipping Packaged Oil

After drums or packages of lubricating oil are filled they are most conveniently handled on roller conveyors. Heavy belts, with almost continuous roller supports can be used to convey and elevate packages or drums up to 120 lb net, provided the pitch is not over 15 deg. Such an arrangement can then elevate packages to a point where further gravity movement on roller conveyers is possible. The conveyors can be equipped with switches so as to distribute the completed shipments at will. Few plants will be able to provide as elaborate a system as is shown in Fig. 21. In this case assembly lines on a lower level permit routing the drums of each individual shipment to a particular line from which all drums are then loaded without further sorting.

Where filled drums or packages are placed in storage, the system shown in Fig. 22, where pallets and a fork-lift truck are used, permits maximum use of available storage room. Lueth[2] describes a unit load concept adopted by one plant. Full drums are handled in units of four, quarter drums in units of nine, 35-lb pails are grouped in lots of 28 units. Orders and shipments are largely confined to multiples of such units.

A further innovation, described by Lueth[2] is the use of a Clark "Pul-Pac" truck which permits elimination of wood pallets. Cases of lubricants are stacked on a sheet of 0.09-in. solid fiberboard, 50 by 46 in. in size. A vertical fence, with a gripping mechanism at the base for gripping the edge of the chipboard pallet, is moved away from or toward the fork truck hydraulically, as the unit load is pushed from or pulled on to the wide plate-type forks on the vehicle.

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LOW COLD TEST OILS TO BE MADE IN UREA DEWAXING UNIT

The growing scarcity of wax-free crudes that are normally used for the manufacture of low-cold-test oils has led Standard of Indiana to make commercial utilization of a German-discovered phenonemon, formation of a solid crystalline aduct when urea is mixed with wax and other straight-chained hydrocarbons.

Speaking at the WPRA's annual meeting in San Antonio on March 25, Standard of Indiana spokesmen said that the new process eliminates the need for the operating temperatures as low as –50 F that would be required for conventional dewaxing processes, costs much less. For example, a 1000 bbl per day urea dewaxing unit producing –50 F pour point oils would cost the same amount — $850,000 — as a conventional dewaxing unit making only 0 F oils.

Operating costs for the two processes would be about the same, too, it was claimed, about 2.2 cents per gallon of finished product for the urea process, and 2.1 cents per gal for conventional dewaxing.

Here's how the process works: Refinery solvent-dewaxed oils ranging from 50 to 220 SSU at 100 F and 0 to 25 F pour point flow into a continuous mixer operating at normal temperatures. Urea is added at a rate of about three pounds per pound of hydrocarbon—about 0.7 mole of urea for each carbon atom—and the urea selectively crystallizes around paraffinic hydrocarbons with long straight chains to make a solid, filterable complex or adduct.

An activator, such as methanol, is used to complete adduction in a reasonable amount of time and also acts as a solvent for the urea.

The mixture of adduct and oil is then filtered, with the filtrate going to an evaporator and then a stripper to remove the activator and inert wash solvent. Because low-viscosity feeds contain more adductable material, feed rate and product yield vary with feed viscosity:

SSU @ 100 F	Feed, B/SD	Yield, Vol %
50	900	85
80	1000	86
220	1200	94

The components of the adduct are easily recovered — either by agitating at room temperature with a good solvent for urea, or by heating. For decomposition by heat alone, adducts of high molecular weight hydrocarbons quickly decompose at 200 F. Heat is used in the commercial process.

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REFINING IN BRIEF

Improved Materials Needed

E. A. Sticha
The Crane Company

THE refining industry has been carrying out large-scale operations at high temperatures for many years. As new processing techniques are developed, requirements for constructional materials change and the air of this presentation is to outline the materials now in common use. Some of the service problems which have been encountered will be discussed also.

Since refinery opreations encompass a wide variety of fluids under diverse conditions of temperature, pressure, corrosion and erosion, a consideration of materials must of necessity be restricted in its scope. Thus, corrosive effects, often all-important in the selection of materials, will be accorded incidental attention only. Mechanical and structural properties, which perhaps best reflect ability to retain fluids under extreme pressure and temperature conditions, then become the prime criteria in choosing an alloy. For high temperature applications strength characteristics as judged by short-time creep and rupture testing are given greatest weight although it should be evident that other requirements as to ductility, corrosion and erosion resistance, structural stability, weldability and so on must be met also.

For most refinery operations conducted at elevated temperatures, it is possible to use iron-base alloys and, of these, carbon steel is employed most extensively. This relatively inexpensive material possesses the desired characteristics to a good degree and it is readily available. We are prone to overlook the versatility of carbon steel as offered by variations in method of manufacture, composition and heat treatment. Under favorable environmental conditions, carbon steel has been used successfully for temperatures as high as 1100 F.

A certain amount of confusion results at times from the assignment of allowable stress values in codes to 1100 F for one carbon steel (e.g. ASTM A106 pipe) while another type of steel (e.g. ASTM A53 bessemer pipe) is limited to 400 F. This situation reflects differences in properties resulting from steel-making practices but which are not revealed by room temperature tensile testing. Bessemer steel suffers a marked loss of ductility and toughness when strained in the 400 to 500 F temperature range and this embrittled condition is revealed best by impact tests on strained and aged specimens. Impact values as low as 2 ft-lb may be realized in this condition. Since the impact that reflects material behavior at points of stress concentrations, it is important in evaluating the applicability of a material.

Where a higher strength material is required for handling fluids at greater pressures, carbon-molybdenum steel piping is frequently employed.

This low alloy steel has essentially the same desirable characteristics as carbon steel in addition to improved high-temperature strength and its field of greatest application is between 700 and 1100 F.

In 1943, a welded carbon-molybdenum steel, main steam line fractured next to a weld as a result of highly localized graphitization. Subsequent surveys of other high temperature steam piping revealed considerable graphite formation in both carbon and carbon-molybdenum steels. Several years later an extensive survey of high-temperature refinery equipment showed similar graphite development in many samples of these steels, also. Although a random pattern of graphite formation seemed to be more prevalent in refinery piping than in steam power piping, the heavily segregated graphitization which caused structural embrittlement was observed too. As in the steam applications, it was noted that higher operating temperatures and longer exposures favored formation of graphite. Again, the potent effect of large aluminum additions (employed for deoxidation of the steel) was shown to be a major factor in promoting development of graphite.

There is a wealth of information on the graphitization phenomenon available to the petroleum industry as a result of difficulties experienced in the steam power field. Much of these data were obtained in the laboratory through use of weld bead specimens exposed under conditions accelerating graphite formation and results correlate quite well with service behavior. In general, the laboratory investigations have attempted to evaluate the effects of variations in melting practice, heat treatment and composition and, of these, the first two approaches have not been particularly fruitful in combating graphitization. Use of alloy steel, specifically chromium-bearing steel, has been adopted by industry as the economical solution to the problem. Most of the other common alloying elements, except possibly manganese, exert no appreciable effect on the progress of graphite formation. On the basis of field and laboratory studies, it has become general practice in the steam power field to restrict welded carbon-steel piping to 750 F maximum and carbon-molybdenum steel to 850 F maximum. While the petroleum refining industry has moved in this direction, there remains a tendency to employ these steels at higher temperatures possibly because of the lesser severity of the problem.

Where processing conditions require greater high-temperature corrosion resistance than is available with either carbon or carbon-molybdenum steel, a wide variety of chromium-molybdenum steels is available. Use of these alloys may start at about 800 F and extend to about 1300 F at the higher chromium level, namely, 9 Cr: 1 Mo steel. The well known 5 Cr: ½ Mo analysis which has served the petroleum industry so admirably for these past 30 years in included in this category.

An indirect consequence of the

(Condensed from the paper entitled "Materials Aspect of Some High-Temperature Refinery Piping Installations", by the same author, presented before the Petroleum Division Conference, ASME, Dallas, Texas, September 1956.)

DU PONT *Petroleum Chemicals* NEWS

One of a Series of Bulletins for the Petroleum Industry

MAY 1957

NEW DIRECTOR OF SALES FOR PETROLEUM CHEMICALS

W. SAM CARPENTER, III, has been appointed to succeed David H. Conklin as director of sales of the DuPont Petroleum Chemicals Division. Mr. Carpenter was promoted to this position from that of assistant director of sales.

Mr. Conklin has been named managing director of the DuPont Company (United Kingdom) Limited. He plans to make his home in London next year.

Alfred R. Mullis, formerly Eastern regional manager of the Petroleum Chemicals Division, replaces Mr. Carpenter as assistant director of sales.

Mr. Carpenter came to the Petroleum Chemicals Division in 1955 from the Cellulosics Division of the Textile Fibers Department where he was director of manufacturing. Prior to joining Textile Fibers, he had been manager of the DuPont Industrial Engineering Division. He joined the DuPont Company in 1938 as an industrial engineer.

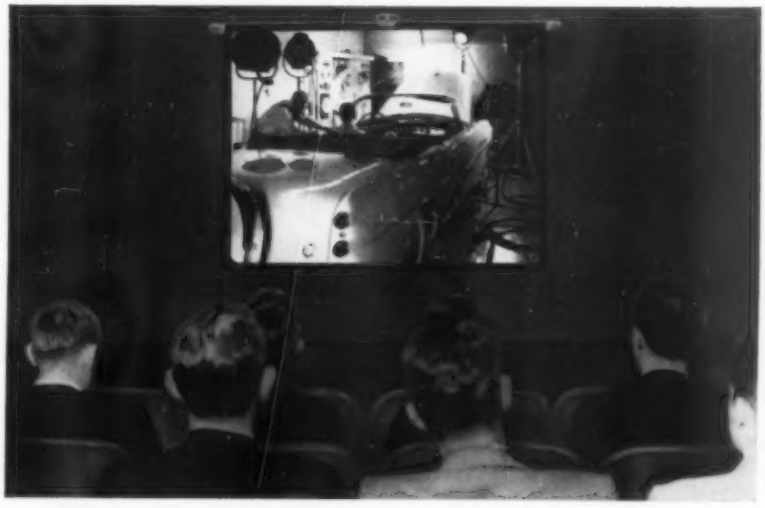
In 1944 and 1945, he was active in the construction and operation of the government's atomic energy project at Hanford, Washington. Mr. Carpenter received his chemical engineering degree from Princeton University.

Mr. Conklin, who came to DuPont as a sales-service representative from Ingersoll-Rand, has been with the Petroleum Chemicals Division since it was organized. He was promoted to West Coast regional manager, then to sales pro-

OVER

Refiners can use these marketing services profitably

The DuPont Petroleum Chemicals Division offers a wide range of marketing aids and services. Many of these are ideal for dealer meeting programs. Others can be profitably used in promotion campaigns. Here is a brief résumé of the DuPont marketing services now available to you:



MOVIES available from DuPont make ideal program material for your dealer meetings.

"When the customer says 'KNOCK'" is a DuPont sponsored, full-color motion picture to instruct dealers on how to handle, in a salesmanlike way, customer complaints about gasoline quality.

This is but one of a series of films. They cover subjects ranging from gasoline quality, just mentioned, to an explanation of the benefits to the public of the percentage depletion allowance. Folders describing these films in detail, along with information on borrowing them, can be obtained from any of our sales offices.

Special demonstration equipment

To help refiners explain quality features of their products clearly and graphically, we have designed and built a number of special demonstration devices. The latest is a machine for showing how carburetor icing occurs and can be prevented with DuPont dimethyl formamide.

I. T. Rosenlund is shown here operating the de-icing demonstration.

This equipment is ideal for pointing up convincingly your product-quality

OVER

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DU PONT *Petroleum Chemicals* NEWS

Du Pont equipment and experience usually available to refiners

REFINER:

Yes, we anticipated that fuel injection systems in cars would raise some new problems in gasoline blending . . .

DU PONT REPRESENTATIVE:

That's right, and our Petroleum Laboratory has already been making road tests using special fuels in injection systems.

REFINER:

Is that so – then maybe you people already have some data we could use?

DU PONT REPRESENTATIVE:

We're accumulating it gradually. We have three fuel-injection cars in our Petroleum Lab.

REFINER:

Good! I hope we can get the results of your investigations.

DU PONT REPRESENTATIVE:

I'll see that you do. As our road tests develop further facts we'll keep you informed.

CONTINUED *Marketing Services*

features to dealer and customer groups.

We can also supply you with a great variety of booklets and visual presentations on gasoline and motor oil quality, customer relations, station services, and other subjects. You can obtain these in large quantities at cost, or at no charge if you'd like only a few copies.

Continuing market surveys

When planning promotion campaigns, you can make use of the findings of our several extensive surveys of customer buying habits and service station operations.

These cover such subjects as the factors influencing a dealer's success, why motorists buy the brands they do, how they select service stations, and which factors in gasoline-brand advertising influence them most.

A report on our latest – and perhaps most important – survey will be finished by mid-summer. The results will be made available to all marketing executives in the oil industry.

Public relations aids

Our newest presentation emphasizes the importance, to everyone, of the petroleum industry – "A 'Brief' Case for Business." It is a lightweight kit which enables you to tell a forceful public relations story in a dramatic way. This kit was conceived and developed by Du Pont and is made available to oil companies through the Oil Information Committee of API, or through your Du Pont representative.

You can probably save time and

continued middle next column

H. C. Thompson displays the "Brief" case public relations kit.

money by supplementing your own promotion program with these useful aids, adapting them to your own purposes. Any of our Petroleum Chemicals Division representatives or sales offices will be glad to give you more information on them.

CONTINUED *New Director of Sales*

motion manager, later assistant director and then director of sales.

Conklin a Navy veteran

During World War II, Mr. Conklin as Commander U. S. Navy, was on active duty 5 years – most of the time in the North Atlantic. He was awarded the Order of the British Empire.

Mullis former sales representative

Alfred R. Mullis joined the Du Pont Company in 1947 as a sales representative in the Gulf Coast Region. He was appointed regional manager there in 1951. The following year he went to New York as Eastern regional manager.

After graduating from Rice Institute with a chemical engineering degree, Mr. Mullis was associated with the Humble Oil and Refining Company in research and development work. While an officer in the Navy from 1942 to 1946, he specialized in petroleum inspection work.

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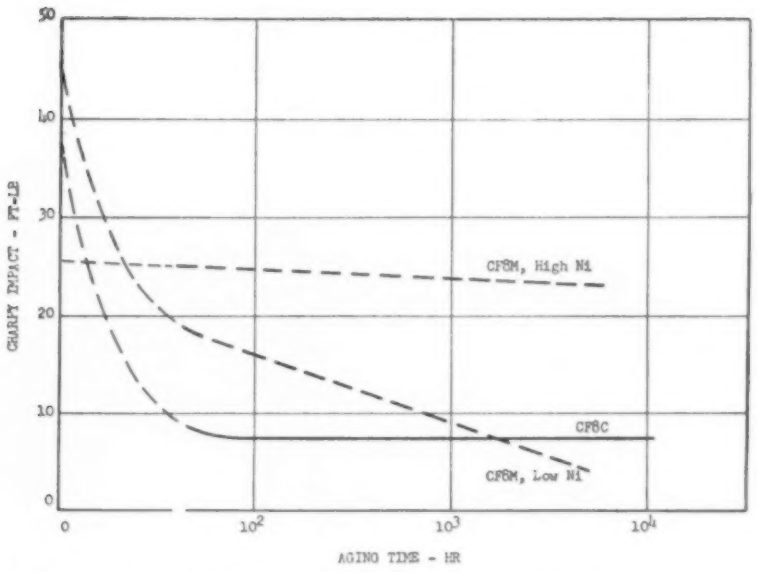

Effect of exposure at 1200 F on the impact resistance of cast austenitic steels.

graphitization phenomenon has been a general lowering of permissible carbon content in alloy casting steels. Whereas a maximum of 0.30 percent carbon was permissible in specifications 10 years ago, the desire to maintain welding characteristics in spite of the chromium additions required for combating graphitization led to lowering of carbon content, usually to a maximum of 0.20 percent. This change resulted in practically identical properties for castings and tubular products to which they were joined and in some improvement in ductility, toughness, and creep strength.

While the great majority of carbon and low-alloy steels in high-temperature refinery piping service retain their desirable properties to a large extent, instances of embrittlement after extended periods of operation have been reported. In general the affected material shows no change in hardness or tensile properties but impact resistance drops sharply. In this respect the phenomenon is similar to temper embrittlement except that considerable time is required to produce the change in behavior. The embrittled condition may be removed by heat treatment, sometimes merely by heating a few hundred degrees above the operating temperature and cooling rapidly. As yet, cause of this deterioration has not been determined.

Welding has become the accepted method of joining refinery-piping elements. In the past, many of the chromium-molybdenum steels were welded with austenitic-steel electrodes, usually the 25 Cr: 20 Ni composition, and not stress relieved. This practice results in a hard and relatively notch-sensitive zone in the chromium-molybdenum steel which is a potential source of failure although troubles from this source have been infrequent. With the development of improved procedures and electrodes of composition matching the base material, there seems to be little need for continued use of austenitic steel electrodes for welding ferritic steels except in certain types of field fabrication.

Where service conditions expose dissimilar metal weldments of this sort to temperatures in excess of 800 F, another potential hazard must be recognized. Carbon diffusion from the ferritic base metal to the austenitic steel weld metal will produce a brittle zone consisting of adjoining decarburized and carbide-rich layers which may fail under unusual loading conditions such as result from cycling temperatures, etc. A similar situation will occur in ferritic steel weldments where a difference in chromium content exists between two of the elements; carbide diffusion may even be evident after application of a post-weld heat treatment.

It is interesting to note that the newer welding techniques are applicable to chromium-molybdenum steels even at the higher chromium levels. Automatic, submerged-arc welding is employed on a routine basis in shop fabrication. Use of the inert-gas-shielded-arc process for making the first pass of pipe welds without backing rings and with or without added filler metal or inserts should receive consideration if complete elimination of internal crevices or projections is desired.

In some instances straight chromium steels of greater alloy content, usually 12, 17 or 27 percent chromium, have been employed to cope with particularly corrosive fluids. Although their strength falls off quite rapidly above 1000 F, they may be used at even high temperatures because of their superior oxidation resistance. They are, however, subject in varying degrees to a loss of ductility called "885 F embrittlement" in which hardness and strength increase while ductility and impact resistance decrease. The 27 percent chromium steel is most susceptible to this form of deterioration, the 17 percent steel less so and the 12 percent steel (AISI Type 410) is apparently not affected at all. A modification of the last analysis containing aluminum (AISI Type 405) does, however, undergo some loss of properties.

The "885 F embrittlement" may be removed by heating in the 1000 to 1200 F range. Prolonged heating, however, above 1000 F and to 1400 F, leads to sigma-phase precipitation which reduces corrosion resistances. A preferred method of eliminating both these conditions is heating above 1500 F and cooling rapidly. Application of the high chromium steels to elevated temperature service is restricted because of these embrittling structural changes.

For extreme pressures, occasionally to temperatures as high as 1500 F, engineers have made use of austenitic chromium-nickel steels because of their high creep and rupture strength. Despite the many excellent characteristics of these steels, they do have some serious defects among which are lack of structural stability as evidenced by susceptibility to intergranular carbide precipitation and sigma-phase formation. Some measure of immunity to these effects may be obtained by modification of composition and by application of a special stabilizing heat treatment.

Casting grades, with wider limits on chemical composition, show greater variations in structure and, hence, of properties. A fully austenitic steel may be obtained if the balance of elements favors this structure while a steel with considerable ferrite results if the reverse is true. Ferrite in austenitic steel is a ready source of sigma-phase and, if the deleterious effects on corrosion resistance and toughness are to be avoided, the amount of ferrite must be minimized. Effects of exposure at 1200 F on impact resistance of two of the more popular austenitic steel casting grades are shown in the accompanying figure.

Welding of austenitic steels in light sections has posed no particular problem. With heavier wall thicknesses, increased restraint has resulted in formation of microcracks in weld deposits.

This condition may be alleviated by composition control to yield a weld containing several percent of ferrite but this type of structure is, of course, subject to the same deterioration at elevated temperatures as similar casting steels. In heavy wall, AISI Type 347 steel for steam power piping, another source of trouble has been encountered in the form of base metal cracking a short distance from the fusion line. The cause of such cracking is not yet understood but it is known that coarse-grained material is more subject to cracking than fine-grained.

Failures of cast austenitic steel valve bodies in thermal cyclic processes have been reported and attributed to thermal shock conditions in which the high coefficient of expansion and poor thermal conductivity of the material combined with repetitive nature of the process are the main factors leading to development of internal cracking. It has been observed that use of ferritic steels and lessening of the temperature swings give longer valve life in this service.

Austenitic steels are subject to stress-corrosion cracking, usually during shutdown periods and due to the presence of chloride ions. Stress for this type of failure may originate in a weldment or from the relatively high coefficient of expansion. The source of corrosive agent may be equally obscure but might originate in condensates, cleaning reagents or brackish water used in hydrostatic pressure testing.

It should be apparent that there is real need for improved materials for many of the high-temperature operations carried out in refineries. ★ ★ ★

LAUGH WITH BARNEY

It takes a second to wink at a girl,
And a lifetime to undo the consequences.

It isn't so much the men in your life,
As the life in your men.

Women were made to be loved—
Not to be understood.

Women are attractive at 20
Attentive at 30 and
Adhesive at 40.

When a married man has the last word,
It's Yes.

Steam is water gone crazy with the heat.

Why tell your troubles to others?
Most of them don't care,
And the rest are glad of it.

If in Heaven we do not dwell—
Hand in hand we'll stand in hell.

A girdle is a blubber band.

A man is getting old—
When he inspects the food
Instead of the waitress.

Survey Shows Octane Ratings Still Climbing

Gasoline on sale at service stations in March rose to national weighted averages of 97.5 octane number for premium and 90.5 octane number for regular, according to the latest monthly survey of antiknock quality compiled by Ethyl Corporation.

Premium gasoline average was 0.2 octane number above the February level and 1.1 octane numbers above a year ago. Regular gasoline average was up 0.1 octane number from February and 1.2 octane numbers higher than a year ago.

Average tetraethyl lead contents in March were 2.52 ml per gal of premium gasoline and 2.00 ml per gal of regular gasoline.

Thirty-eight of the 53 cities in Ethyl's survey reported increases over February in the average octane number of their premium gasoline, five of them by 0.5 octane number or more. Nine cities reported decreases while six cities remained unchanged. In regular gasoline, 28 cities reported increases over February in their average antiknock quality, eight of them by 0.5 octane number or higher. Seventeen cities reported decreases, and eight cities remained unchanged.

Compared with the nationwide premium average of 97.5 octane number, 20 cities reported premium averages of 98 octane number or higher. In regular gasoline, 16 cities showed average octane ratings of 91 octane number or higher, compared with the national weighted average of 90.5 octane number.

Average Research Octane Number Trends in 53 Marketing Centers

	Premium Gasoline			Regular Gasoline		
	Mar. 1957	Feb. 1957	Mar. 1956	Mar. 1957	Feb. 1957	Mar. 1956
Albuquerque, N. M.	96.6	96.5	95.8	86.6	86.3	86.4
Amarillo, Tex.	97.8	97.2	96.6	89.1	89.1	87.5
Atlanta, Ga.	98.1	98.0	97.6	89.8	89.8	89.4
Bakersfield, Calif.	96.5	96.3	95.7	86.9	86.4	85.8
Baltimore, Md.	98.5	98.2	97.2	92.6	92.8	91.2
Billings, Mont.	94.2	94.0	93.9	87.9	87.2	86.6
Birmingham, Ala.	98.6	98.2	97.5	90.1	89.7	89.2
Boston, Mass.	98.6	98.2	97.5	92.6	92.6	91.5
Buffalo, N. Y.	98.1	97.8	97.5	92.4	92.2	91.5
Casper, Wyo.	94.4	94.4	92.7	87.0	86.1	85.3
Central Mich.	97.3	97.0	95.8	90.9	90.9	89.7
Charlotte, N. C.	98.2	98.4	97.4	89.4	89.2	89.4
Chicago, Ill.	97.2	96.8	95.3	91.3	91.2	88.4
Cincinnati, Ohio	98.0	97.6	95.8	91.6	91.6	91.0
Cleveland, Ohio	98.1	98.1	95.7	91.6	91.7	90.9
Corpus Christi, Tex.	98.7	98.5	97.1	89.1	89.6	89.2
Dallas-Fort Worth, Tex.	98.2	97.8	97.3	89.2	89.1	89.1
Denver, Colo.	94.1	94.3	92.4	85.5	85.3	84.3
Detroit, Mich.	97.5	97.4	95.5	91.9	91.6	90.3
El Paso, Tex.	97.6	96.4	95.3	87.7	86.9	86.5
Fargo, N. D.	96.3	95.9	93.6	88.4	88.1	85.6
Hartford, Conn.	98.5	98.1	97.1	92.6	92.8	91.7
Houston, Tex.	98.0	98.1	97.0	89.4	89.4	88.3
Indianapolis, Ind.	97.8	97.5	95.6	91.5	91.6	90.0
Jackson, Miss.	97.9	97.7	97.3	89.7	89.4	89.1
Jacksonville, Fla.	98.0	97.8	97.3	90.8	91.0	90.7
Kansas City, Mo.	96.7	96.5	94.2	88.4	88.8	86.7
Little Rock, Ark.	98.2	97.9	97.1	89.6	89.7	89.2
Los Angeles, Calif.	96.7	96.5	96.2	86.4	86.4	86.2
Louisville, Ky.	97.3	97.4	96.6	90.6	90.0	89.2
Memphis, Tenn.	98.3	98.2	97.3	90.0	89.8	89.4
Metropolitan New York-New Jersey	98.1	98.0	97.2	92.7	92.4	91.5
Milwaukee, Wis.	97.1	97.1	95.4	91.3	91.5	89.1
Minneapolis-St. Paul, Minn.	96.2	96.5	94.6	88.8	88.9	86.7
New Orleans, La.	98.1	98.0	96.8	89.2	89.6	89.0
Northwest Pa.	96.8	96.9	95.7	92.4	92.1	91.0
Oklahoma City, Okla.	96.7	96.6	94.5	88.6	88.5	86.2
Omaha, Neb.	96.2	96.1	93.9	88.0	88.2	86.0
Philadelphia, Pa.	98.3	97.8	96.9	92.8	92.5	91.5
Phoenix, Ariz.	96.7	96.6	96.6	87.5	87.4	87.0
Pittsburgh, Pa.	97.9	97.9	97.5	92.7	92.6	92.2
Portland, Ore.	96.9	96.8	96.2	87.3	87.5	86.9
Richmond, Va.	98.3	97.6	97.5	92.1	91.8	91.4
Salt Lake City, Utah	94.2	94.1	93.0	83.9	83.0	82.2
San Antonio, Tex.	97.8	97.7	96.8	88.9	89.0	88.5
San Francisco, Calif.	97.1	96.8	96.2	87.7	86.9	86.5
Seattle, Wash.	96.4	96.6	96.0	87.1	87.2	86.5
Shreveport, La.	98.3	97.8	97.2	89.6	89.7	88.7
Spokane, Wash.	96.5	96.6	95.7	87.4	86.9	86.7
St. Louis, Mo.	96.6	96.6	94.2	90.6	90.4	86.5
Toledo, Ohio	97.9	97.9	95.8	91.7	91.7	90.9
Tulsa, Okla.	96.9	96.7	94.5	88.7	88.6	86.5
Wichita, Kans.	96.2	96.3	93.9	88.4	88.6	86.2

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for the Best in Gas Boosters

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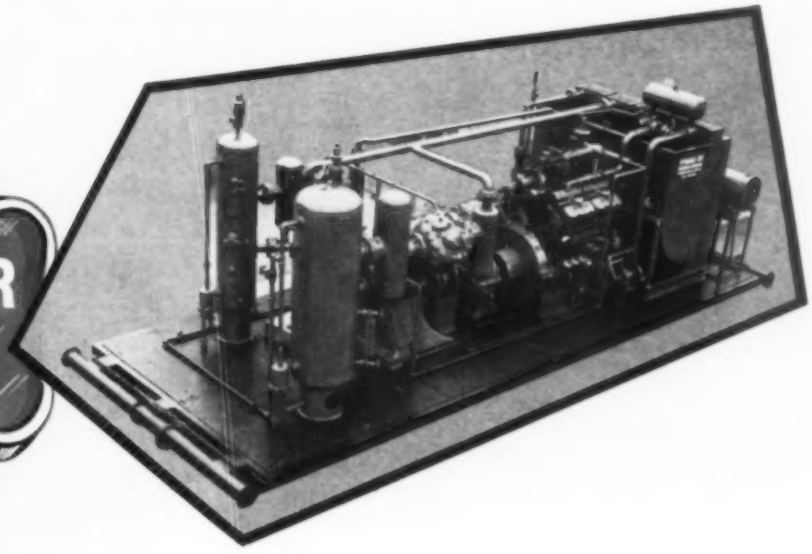
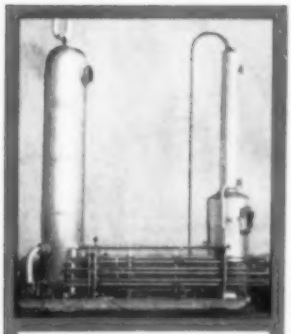


Pictured above is a McNamar - Joy WNB-112 twin cylinder gas compressor. This unit, located in the Rocky Mountains, is boosting 0.5 MMCFD gas from a suction of 15 psig, discharging at 800 psig.



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McNamar's De-Sulphurization units assure dependable, economical operation and require minimum attendance. The completely packaged McNamar amine units are designed to sweeten the sour gas and make it a saleable product. Sufficient anti-corrosion measures are made to insure a longer maintenance-free plant operation.

The McNamar vertical air discharge cooler provides engine and jacket water cooling, also gas inter-cooling and after-cooling. It is a two stage, double acting, 200 horsepower compressor. The unit is direct connected through a gear reducer for minimum horsepower loss. Approximate weight is 24,000#. The overall dimensions are 7′ wide x 22′ long.

The complete unit is mounted on a single skid for compactness and ease of handling. The McNamar-Joy units are completely packaged with inner connecting piping, scrubbers, valves and safety controls and require only two connections to place in operation.

McNamar-Joy compressor units are designed to your individual applications and are available on *purchase, rental* and *rental purchase option* basis.

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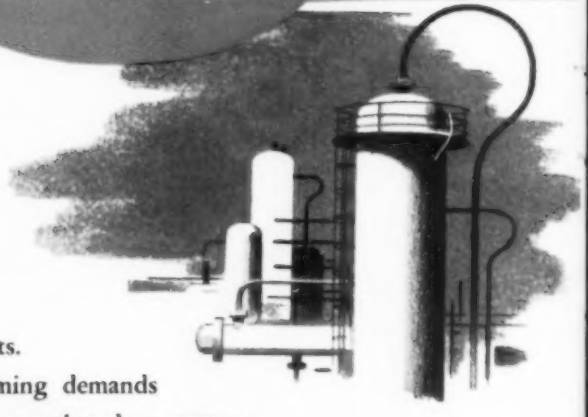

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Whatever its application, catalytic reforming demands *unerring accuracy* in the heat transfer equipment employed—accuracy in rating—in design—in welding—in complete fabrication.

Western Heat Exchangers meet these demands because Western's rating and design engineering—manufacturing techniques—close attention to detail—are dedicated to *accuracy first*.

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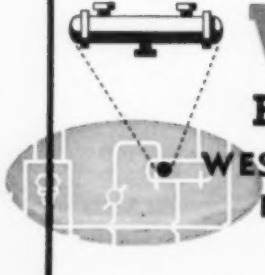
Western's representatives stand ready to serve you . . .



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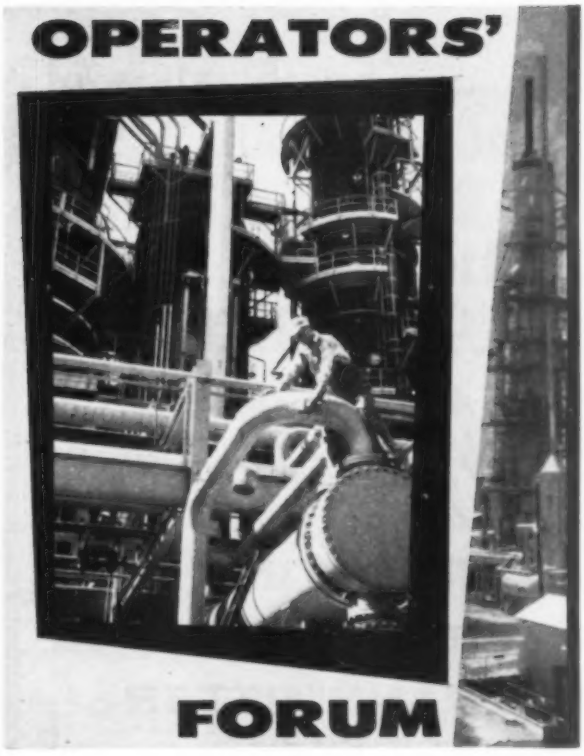

Q **What are the essential operating conditions maintained in (a) low pressure, and (b) high pressure polymerization of ethylene?**

M. D. T.

POLYMERIZATION OF ETHYLENE

A The first commercial polyethylene or "Polythene" was made by the so-called "high pressure process" of ICI in England employing pressures of the order of 1000 to 2000 atm (15,000 to 30,000 psi). Since then, processes using different catalysts have been developed operating at lower pressure with obvious economic advantage. In general, the "low pressure processes" using peroxide type catalysts and metal oxides operate in the range of 1000 to 5000 psi, while those using metal alkyl catalysts (Ziegler type) can be run at pressures down to one atmosphere or even less. Even with these, however, economy would indicate use of moderately higher pressures to reduce the size of the apparatus for a given throughput. In effect then, there are three processes, high pressure, low pressure and intermediate.

In the high pressure process, ethylene gas of high purity is compressed to 1000 to 2000 atm and held at about 200C with a carefully controlled amount of oxygen — less than 0.2 per cent. Yields increase with the oxygen content but the molecular weight of the product decreases. Molecular weights in the range of 10,000 to 50,000 are obtained and the product density is about 0.92. The Spencer Chemical Company[1] is said to be operating a modification of this process which produces a resin with a density of 0.935 — 0.94, but the conditions have not been disclosed.

An emulsion polymerization process is also described[2] employing hydrogen peroxide and potassium persulfate as catalysts at 900 atm pressure and 90C.

The conditions for the low pressure process of Ziegler[3] involve suspending the catalyst consisting of aluminum triethyl and titanium in an inert hydrocarbon oil and passing in ethylene gas at a temperature of about 70C. A conversion rate of 200 liters of ethylene per hour per liter of catalyst oil mixture can be obtained. The product is washed with alcohol to convert the aluminum and titanium to alcoholates.

The product is strong and has a higher softening point than the high pressure product, the density being 0.935 to 0.970. The hydrocarbon oil acts as a solvent for the ethylene, providing a liquid phase reaction, even though the ethylene is above its critical temperature (9.7C).

Robert C. Wade recently described at MIT a method of making the aluminum trialkyl catalyst in-situ from sodium hydride, aluminum chloride and titanium tetrachloride in the presence of ethylene. Handling the inflammable metal alkyls is thus avoided. James Knap[4] outlines methods for handling aluminum alkyls under inert gas, such as nitrogen or argon. Burns on the skin from these catalysts are slow to heal.

Numerous patents[5] of the Standard Oil Company (Indiana) describe the use of partially reduced oxides of molybdenum, vanadium, nickel, chromium, etc. Calcium metal or calcium hydride or molybdenum oxide can be used. These catalysts are used at pressures below 1000 psi and temperatures of about 100 to 350C. Peroxide catalysts such as ditertiary butyl peroxydicarbonate are also patented by Standard Oil Company (Indiana), US 2728755 showing an emulsion technique.

The Phillips Petroleum Company process employs a chromium catalyst supported on alumina-silica.[6] The catalyst, called the "Marlex" catalyst, is described in a recent paper by Clark, et al,[7] which also gives the reaction conditions. Purified ethylene, free of water, oxygen and CO is passed with a volatile

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- **More Compact . . . single, integral instrument**

Any way you look at it, the new Foxboro M/44 Pneumatic Pressure Transmitter gives you an unmatched combination of fine engineering and economy. First; because it *is* an engineered instrument. There are no attachments or "makeshifts". Second; because it utilizes standard Foxboro parts throughout—parts which have been performance-proved in thousands of successful installations of other Foxboro Instruments. And this means not only top performance, but easier servicing and stocking as well. Third; calibration is simple, right in the field, because the M/44 is "convenience-designed" by men with years of experience in every phase of instrument design and application.

In appearance, too, the M/44 has unmistakable Foxboro quality. Features like the high-legibility indicator scale, the compact drawn-steel case with tough polyester plastic cover. It's the neat, high-efficiency, low-cost pressure transmitter for centralized operation or control. All standard ranges.

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INSTRUMENTATION FOR INDUSTRY

hydrocarbon solvent over the catalyst bed at 150 to 180C. Higher molecular weight resin results from a suspended catalyst operation at 400 to 500 psi and temperatures below 500C. Small amounts of higher olefins are found to co-polymerize with the ethylene, modifying the properties of the resin product.

The properties of the polyethylenes are given by Grams and Gaube[8] and by Raymond Seymour,[9] the latter giving a good review of the literature on applications of the resin to various uses.

High density, high strength and resistance to softening with heat go hand in hand in the polyethylene resins. High density resins are therefore adapted to many articles that must withstand boiling water without notable deformation. Low density resins have the advantage of producing more articles per pound or more square feet of film per pound of resin. The low pressure polymers have higher density, tensile strength and hardness than the high pressure polymers but their elongation and impact resistance is inferior. The various physical properties of the polyethylenes are discussed by Jones & Boeke[10] and the molecular structures as shown by X-ray spectra are discussed by D. C. Smith[11].

Hardening of polyethylene resins by cross linking chain molecules when subjected to bombardment in the atomic pile at Harwell, is discussed by Charlesley[12]. The Sequoia Chemical Company of Redwood City, California, is employing a process developed by Graham of Stanford Research Institute[13] for electrical insulation in which the polyethylene covering is subjected to high intensity beta and gamma radiation.

The art of polmerizing ethylene to high mocelular weight resins is moving so rapidly that we can be sure many changes in present processes will be made in the near future. The tremendous commercial importance of the product, as shown by a production of three-fourths of a billion pounds in 1957 (estimated) warrants extensive research on the several methods already discovered for it's manufacture.

Vandever Voorhees.

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SILICONE OILS GOODS— IN SOME APPLICATIONS

Q Under what conditions of pressure, temperature, etc., are silicone oils especially fitted for various lubrication applications? Under what conditions is their use not recommended?

E. D. L.

A Silicone oils have excellent or high viscosity-temperature index (VI); much better than SAE 5w-20 or 10w-30 motor oils—in fact beyond where VI on the ASTM scale is feasible to state. Having sub-zero pour points their fluidity at over zero temperatures are very satisfactory as are their low torque values. Silicone oils have lower increases in viscosity with high pressures than do the best of straight mineral oils.

Due to their resistance to oxidation and their low evaporation loss, they are suitable for high temperatures (450 F) but since their lower film strength and low EP characteristics, Silicone oils are limited to application factors below those of straight mineral oils at similar operating viscosities. Thus, with anti-suction bearings and gearing lower operating pressure should be selected.

In jet engines the Air Force tests have shown lower anti-friction bearing life and excessive gear scuffing and wear. Blended with synthetic esters they are improved but not equal to the minimum EP rating of 2000 lb on the Ryder or Pratt and Whitney Gear Tester used in Air Force Specs. for jet engine lubricating oils. The synthetic esters meet this requirement. Because of the high price per pound of Silicone oils their use as lubricants either as oils or in greases are limited to specialty applications where stability at high temperatures, low torque at sub-zero temperatures (or both) are encountered but where minimum pressures and excessive high speeds (20,000 rpm in smaller anti-friction bearings) are not exceeded.

C. M. Larson

GR-S (Tire Type) RUBBER SYNTHETIC

Q Is GR-S rubber still considered the best of the synthetic for tire treads and similar rough usage? What has been accomplished in the last few years in reducing the heat-up tendencies of GR-S rubbers in service, and how have the results been accomplished, in the main?

C. F. E.

A GR-S is still the best synthetic for commercial tire treads and equivalent high abrasion service. There have been no major improvements in reducing the heat build-up in GR-S polymers though some minor advances have been made in this regard in compounding through carbon black adjustment. Today the great majority of passenger tires are at least 99 percent synthetic rubber whereas in truck tires the tread is GR-S but natural rubber is employed in the tire carcass or interior because there is less heat build-up with natural rubber than with GR-S.

Dr. James H. Boyd

REFINING AND PETROCHEMICAL PERSONALS

Members of Houdry Process Corporation's 20-Year Club gather to elect and install new officers and to initiate new members. They are some of the men who witnessed the completion and operation of Houdry's first catalytic cracking unit which began petroleum's "catalytic revolution" in 1936. Left to right (seated) are: A. G. Oblad, vice president; Raymond Newirth; Austin Proctor; W. F. Faragher, now retired; G. R. Bond, W. V. Velykis; H. A. Shabaker; and Andrew Campbell, Jr. Standing are: G. H. Daft, vice president; R. E. Bland, new 20-Year Club president; J. A. Redmond; G. L. Long; H. A. Mount; C. R. Stevenson; C. A. Bratton; R. W. Blades; P. M. Quilleret; C. C. Peavy, vice president and company representative; R. B. Cross; G. L. Barcus, new club secretary-treasurer; and A. W. Hoge, director of engineering. Oblad, Daft, Peavy and Hoge are not club members but represent the company.

Quoth Sir Galvaknight: Only Complete PROTECTION is Good Enough

And the best *complete* anti-rust protection for iron and steel is hot-dip galvanizing. The hot-dip process seals out corrosion on *all* surfaces, as no other protective coating can. Armor-plate your iron and steel with hot-dip galvanizing by the Southwest's largest commercial galvanizers, the Nowery J. Smith Company!

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▸ **H. W. Torgeson** has been named manager and **H. R. Shepherd, L. G. Brannin** and **C. W. Rohler** as assistant managers of the Cities Service Oil Company refinery at Ponca City, Oklahoma. **S. R. McMurry,** who has been manager of the Ponca City refinery is being transferred to Bartlesville as special representative in the industrial relations division. **M. E. Wooldridge,** plant superintendent, will head the operations department in the refining division's headquarters offices in Bartlesville.

▸ **W. Ward Jackson,** vice president of Commercial Solvents Corporation, has been named to head the company's sales and marketing activities. His new responsibilities will also include the corporation's advertising and sales promotion, market development and traffic activities. Jackson was previously vice president of CSC's petrochemicals division.

▸ **R. V. McGrath** of Bartlesville, Oklahoma, has been appointed staff assistant to the manager of Cities Service Oil Company's refining division and **J. S. Brendler** has been named head of the division's new technical department. McGrath will act as a special technical and administrative assistant and steps into the new position from the post of chief process engineer.

▸ **B. J. Schulz,** chief process engineer at Magnolia Petroleum Company's refinery in Beaumont, Texas, has been transferred to the headquarters staff of the Socony Mobil Oil Company, Inc., laboratories in New York and will assume the position of coordinator of lubricants and allied products. **R. E. Woodham,** formerly assistant chief process engineer, has been promoted to chief process engineer at the refinery in Beaumont.

▸ Standard Oil Company (Indiana) has announced the appointments of **Clifford T. Nicholson** as administrative assistant and **James E. Bryan,** formerly assistant office manager, as supervisor of administrative reports in the office of President Frank O. Prior. **James N. Roper** was named to succeed Nicholson as superintendent of the refinery projects division at the Whiting, Indiana, refinery.

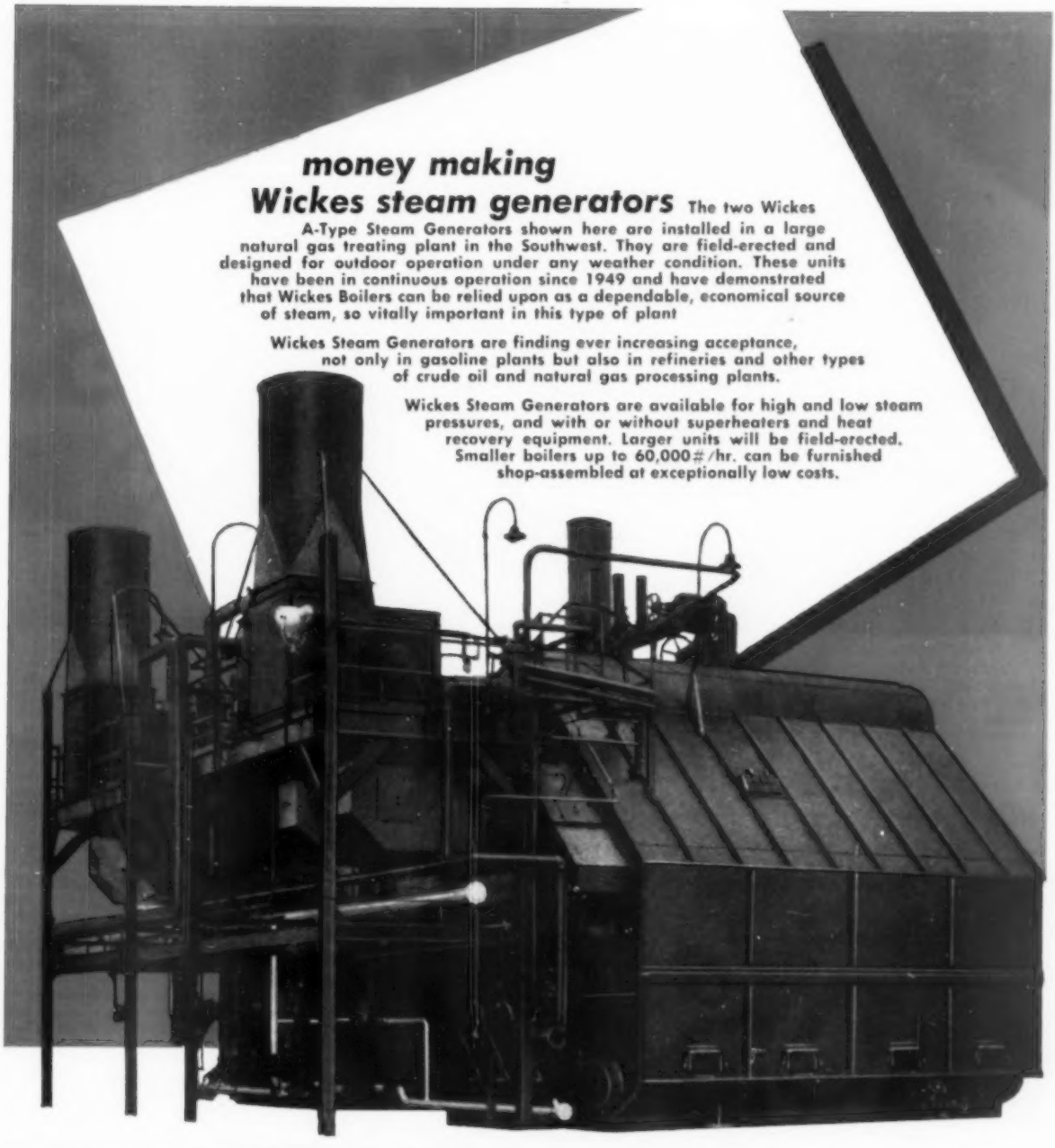
▸ **John W. Newton,** vice president and manager of Magnolia Petroleum Company's refining division at Beaumont, Texas, has retired.

▸ **P. L. Robison** has been made manager of The Atlantic Refining Company refinery at Port Arthur, Texas. He succeeds **Robert Stewart,** who is retiring after 46 years of service with the company. **B. E. Milner,** technical assistant to the manager, has been named general superintendent at the refinery. Robison was assistant manager.

▸ **C. L. Wallace,** formerly superintendent of the Ohio Oil Company's Lovell, Wyoming, refinery, has been transferred to the Robinson, Illinois, refinery. He will be responsible for coordinating all maintenance work at the refinery.

▸ **David W. Dolson** has been named manager of crude oil and products supply at Leonard Refineries, Inc. He was formerly manager of crude oil purchases and sales at Leonard Crude Oil Company, Mt. Pleasant.

▸ **Harold F. McGuire** has been elected to the board of Commercial Solvents Corporation. He is a member of the law firm, Wickes, Riddell, Bloomer, Jacobi and McGuire, general counsel to Commercial Solvents.



money making
Wickes steam generators

The two Wickes A-Type Steam Generators shown here are installed in a large natural gas treating plant in the Southwest. They are field-erected and designed for outdoor operation under any weather condition. These units have been in continuous operation since 1949 and have demonstrated that Wickes Boilers can be relied upon as a dependable, economical source of steam, so vitally important in this type of plant

Wickes Steam Generators are finding ever increasing acceptance, not only in gasoline plants but also in refineries and other types of crude oil and natural gas processing plants.

Wickes Steam Generators are available for high and low steam pressures, and with or without superheaters and heat recovery equipment. Larger units will be field-erected. Smaller boilers up to 60,000#/hr. can be furnished shop-assembled at exceptionally low costs.

166

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DIVISION OF THE WICKES CORPORATION
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FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

NOW... pre-mixed additives offer new convenience to refiners

NEW combination prevents gel-clogging in fuel lines as well as sludge-plugging of filters, screens and nozzles

Now Du Pont offers the protective qualities of two additives, pre-mixed for your convenience: Fuel Oil Additive No. 2 (FOA-2) and Du Pont Metal Deactivator (DMD). Respectively, they provide outstanding stabilizing and dispersant action, and protection against the effects of copper contamination.

The result is a solution that guards against practically all the major chemical causes of oil burner troubles and failures.

The new additive is available in two different concentrations. One, FOA-208, is composed of 8% DMD and 92% FOA-2. The other, FOA-212, is a 12% DMD, 88% FOA-2 solution.

Stabilizer and dispersant

The stabilizing action of Du Pont FOA-2 retards the formation of insoluble residues during bulk storage and in customers' tanks. The dispersant action of FOA-2 reduces the size of the particles in any residues that may form.

In these two ways, it prevents a build-up of sludge that causes clogging of filters, screens and nozzles.

Prevents gel-clogging

Clogged fuel lines are generally due to the formation of a gelatinous material. This is frequently caused by contamination from copper in screens, feed lines, valves and other fuel handling equipment. DMD prevents this effect of copper contamination . . . thus preventing the need for many service calls due to gel-clogged fuel lines.

Now, it is possible for refiners to add this complete three-way protection in a single operation. For best results, Du Pont FOA-208 or 212 should be added to freshly prepared stocks at the refinery.

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FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

E. W. Fisher, product engineering manager for The Garlock Packing Company of Palmyra, New York, addressed the American Society of Lubricating Engineers at their dinner February 20. Fisher spoke on "Packings for Fire Resistant Fluids."

E. W. Fisher

Earl Noblet

Earl Noblet has been named assistant manager of market development for Sinclair Chemicals, Inc. He had previously been engaged in market research activities.

Dr. John G. McNab has been appointed coordinator of petroleum products and medical research at Esso Research and Engineering Company.

Harry J. Kennedy, Houston, Texas, vice president of Continental Oil Company, has been elected president of the Western Petroleum Refiners Association at the group's 45th annual meeting in San Antonio, Texas. He succeeds **Reid Brazell,** Alma, Michigan, president of Leonard Refineries, who has been WPRA president since 1955.

F. L. Martin, Corpus Christi, Texas, Suntide Refining Company, was re-elected a vice president. New vice presidents elected were **W. J. Carthaus,** St. Paul, Minnesota, Great Northern Oil Company; **Rex Blazer,** Cleveland, Ohio, Allied Oil Company; **Walter Famariss Jr.,** Hobbs, New Mexico, Famariss Oil & Refining Company, and **J. A. Vickers,** Wichita, Kansas, The Vickers Petroleum Corporation. New WPRA directors were **C. R. Brown,** Tulsa, Tidewater Oil Company; **L. W. Robbie,** Texas City, Texas, Republic Oil Refining Company; **R. G. Sanders,** Beaumont, Texas, Magnolia Petroleum Company, and **E. M. Stone,** Denver, Colorado, Empire Petroleum Company.

L. Wayne Hicks of Yorktown, Virginia, has been appointed assistant director of American Oil Company's general engineering department. He will make his headquarters at the company's Texas City, Texas, refinery. He formerly was project inspector for the company's Yorktown refinery.

L. W. Hicks

H. J. Rose

Harold J. Rose has been appointed assistant general manager of Esso Standard Oil Company's chemical products department. He has been coordinator of chemicals research for the Esso Research and Engineering Company.

A. S. (Steve) Gilliam has been appointed plant manager of Great Northern Oil Company's Pine Bend refinery, Pine Bend, Minnesota. He has most recently been project manager and assistant plant manager of the Olin-Mathieson Chemical Corporation.

Virgil C. Grisham, right, smiles as he accepts a check for $800 from Benjamin G. Jones, assistant manager of Tidewater Oil Company's new Delaware Flying A Refinery, nearing completion 15 miles south of Wilmington. Looking on is Vice President H. Y. Hyde, Tidewater's manufacturing department manager. The check was awarded Grisham for submitting the second most meritorious suggestion last year under the company's nationwide suggestion system.

Three key promotions have been made within Phillips Chemical Company. **A. J. Head,** formerly director of Phillips Chemical's manufacturing division, is promoted to the newly created position of manager of the manufacturing divisions, and **R. G. Rhodes,** formerly manager of the company's chemical manufacturing facilities at Adams Terminal on the Houston Ship Channel, is promoted to the newly created position of director of plant operations. Both men will be headquartered in Bartlesville, Oklahoma. **L. H. Johnstone** succeeds Rhodes as plant manager at Adams Terminal.

Dr. Irving D. Webb has been appointed manager of the chemical research division, Union Oil Company of California. He will be responsible for research and technical service in the petrochemical product activities of Union Oil and particularly the company's wholly-owned subsidiary, Brea Chemicals, Inc.

Joseph T. Froehlich has been named superintendent of The Texas Company's new Anacortes, Washington, refinery. He has been a superintendent — special assignments in the refining department's headquarters in New York.

L. W. Newton has been appointed assistant to the vice president-research, of Carbide and Carbon Chemicals Company, a division of Union Carbide and Carbon Corporation. He has been engaged principally in administrative duties at Carbide's research center in South Charleston, West Virginia, until his current promotion.

Dr. C. Loyal W. Swanson has been appointed agronomist in the research and technical department of The Texas Company. In addition to his technical service activities, he will direct Texaco's research in experimental applications of synthetic plant nutrients.

Winston S. Peeler, of Texas City, Texas, has been promoted to the position of general manager of manufacturing of American Oil Company. Peeler, formerly general superintendent, succeeds **Roy J. Diwoky,** who resigned recently.

A. E. Crouse, former regional superintendent of natural gasoline and gas operations, Fort Worth, Texas, has been transferred to Houston, Texas, as coordinator in plant operations for Continental Oil Company.

Blanton C. Duncan, a physical chemist, has rejoined the Surface Chemistry Section, of the National Bureau of Standards. He joined the NBS staff in 1950 as a chemist. In 1952 he began work toward his doctorate at the State College of Washington and is to be awarded his PhD in physical chemistry in June 1957.

W. B. Schnick has replaced **J. D. Hurst** who retired this year, as manager of traffic and shipping for Magnolia Petroleum Company's refinery in Beaumont, Texas. Schnick was assistant manager prior to this promotion. **R. P. Medlin** has been named chief process engineer in the technical department. Medlin replaces **B. J. Schulz** in that capacity. Schulz has become coordinator of lubricants and allied products in the headquarters staff of Socony Mobil Oil Company, Inc. laboratories in New York. **E. J. Reeves,** assistant chief process engineer in technical department's plant testing section, has been shifted to Medlin's previous job of planning and coordinating assistant chief process engineer. **R. A. Bowden** formerly an assistant chief process engineer in the plant's process control laboratory has replaced Reeves. **W. D. Douglas** was named storehouse foreman at Beaumont replacing **E. A. Young,** who retired. **H. C. Stokes** has replaced Douglas as assistant storehouse foreman and **Herman F. Carr** has moved up to the position of storehouse supervisor.

Six men have been appointed to key positions in Continental Oil Company's Ponca City operations. **Loyd Thompson,** assistant superintendent in charge of the Ponca City refinery's mechanical division, to general maintenance engineer, manufacturing department. **G. W. Willoughby,** mechanical superintendent, succeeds Thompson. **Roy E. Kennedy,** general craft supervisor, to mechanical superintendent, replacing Willoughby. **Dale M. Tague,** division engineer, succeeds Kennedy. **S. E. Hickerson,** division engineer, light oil division, appointed division engineer for the catalytic cracking division, replacing Tague. **Johnie Marchesoni,** mechanical inspector, headquarters division, succeeds Hickerson.

Dr. George F. Kirby Jr. has been elected a director of Ethyl Corporation. Dr. Kirby, who is vice president in charge of research and development for the company, has been associated with Ethyl Corporation since 1940.

D. C. Ritchey has been appointed supervisor of the Ohio Oil Company's refining and marketing accounting department. He succeeds C. M. Buffington, who died. Ritchey was transferred to the controller's staff earlier this year.

NEW Refining Equipment

• machinery • supplies • services

For more information on items described here in brief, use the handy reply card and circle the corresponding numbers

Teflon-Sleeved for Severe Services. A line of stainless steel plug valves, tradenamed Tufline, has been introduced. New units are compact and ruggedly designed, have Teflon sleeves which eliminate need for any lubrication. An unusual design feature is the internal ribbed construction which locks the sleeve in position for high-pressure continuous sealing around body ports and bore, yet permits sleeve expansion and contraction without leakage. *Continental Manufacturing Co.*

Circle number (41) on reply card.

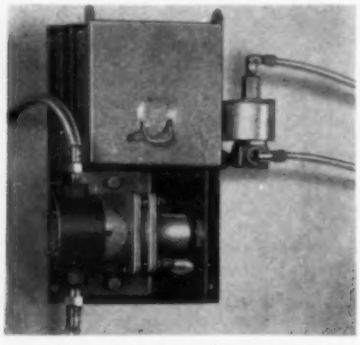
Null-Balance-Vector Transmitters. Pressure and differential pressure transmitters utilizing a "null-balance-vector" principle have been added to Republic Flow Meters Company's line of power and process instruments. Design principle permits greater compactness, reduces weight, and permits changing of each instrument's range with a simple screw driver adjustment. Standard models of both instruments operate on 20 psi air and produce output signals from 3 to 15 psi, normally using about 0.2 scfm of air. *Republic Flow Meters Co.*

Circle number (42) on reply card.

Permanent Vulcanized Cable Splices. Vulcanized, Neoprene insulated cable splices without power loss can now be produced, in the plant or in the field, in just 5 minutes with a new portable cable splicing kit. The new 110-v kit makes permanent cable splices which are flexible, waterproof and shockproof. Cable insulation is simply stripped back. Bare ends of cables are then inserted in a copper tube supplied, and are crimped with the high pressure crimping press in the kit. CAM-LOK Division, *Empire Products, Inc.*

Circle number (43) on reply card.

Diaphragm Feeder Handles Concentrated Chemicals. An economical, wall-mounted diaphragm feeder for handling concentrated chemicals directly from shipping containers (for greater safety) has been developed. Feeder, Model 19130 Proportioneer, offers improved operating efficiencies and construction permits handling minute amounts of most corrosive chemical solutions. Pumping rates, from 0.8 to 8.0 gal per 24 hr period, are adjustable by varying the stroke length and stroking frequencies. *Proportioneers, Inc.*

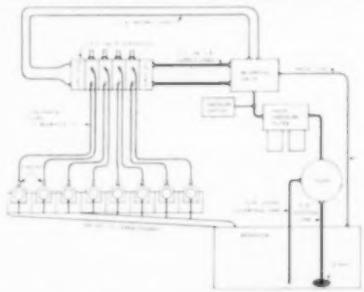


Circle number (44) on reply card.

Sump Pump Resists Corrosion. Self-contained portable sump pump has wide application in the removal of sludge, chemicals, oil, clean or dirty water from sumps, wells, excavations and cellars. Pump body, impeller, and strainer are made of bronze to resist corrosion and insure spark-free operation. Chemical solutions and inflammable or explosive liquids can be handled safely. *Schramm, Inc.*

Circle number (45) on reply card.

Lube System Circulates Oil. A new type of circulating oil system marketed under the trade-name Lubrival has been developed. Designed to serve lubrication needs of automatic and semi-automatic equipment, it employs the 2-line principle of operation to supply oil under pressure to progressive dualine measuring valves. Valves have individual sight indicators and feature the positive piston displacement method of feeding lubricant. Lubrival monitors its own operation through a pressure sensing mechanism to warn of clogged or broken lines in any part of the system. *The Farval Corporation.*



Circle number (46) on reply card.

Three New Jibs Double Capacities. Link-Belt Speeder unveiled 3 new high-capacity jibs, 20, 30 and 40 ft in length, with 6, 5 and 4-ton maximum capacities. Jibs are for use on their 88, 98, and 108 series crawler and rubber-tired shovel-cranes. Basic factor behind increase is a high-strength alloy steel which equals or surpasses the strength of, but is considerably lighter than standard structural steel. Boom is a 2-piece, 20-ft, all-welded, box lattice unit. *Link-Belt Speeder Corporation.*

Circle number (47) on reply card.

New Compressor Valve for Air and Gas. A new concept in compressor valve design has been introduced by the Ball Valve Company. Designated the BV valve, it uses the ball check valve principle instead of the plate valve technique widely used at this time. Design uses a multitude of spring-loaded check valves built into the valve body. Advantages to the petroleum industry indicated by manufacturer are simplicity of design; streamline flow for greater valve efficiency, reliability in that instantaneous failures can not occur; and lower maintenance costs due to ease in reconditioning of valve and greater valve life. Valves are designed for use in compressors in the refining, gas processing, and gas transmission industries as well as air and gas drilling. *The Ball Valve Company.*

Circle number (48) on reply card.

Pressure Relief Valve. A new pilot operated pressure relief valve best adapted for gases and vapors is the Model 416. Valve answers the need for a simple and accurate yet safe and dependable means of relieving excessive pressures at strategic points in pressure systems due to surges, line blocks, control failure, or human error. *Kinzbach Tool Company, Inc.*

Circle number (49) on reply card.

Portable Mass Spectrometer. Problems of analyzing extremely small amounts of gaseous mixtures, or liquids capable of being vaporized, are solved with a new, inexpensive, portable mass spectrometer designed for both laboratory and industrial use. Known as the Type 21-611 Mass Spectrometer, instrument was developed to provide an accurate but inexpensive, small-size model for medical, industrial, and university applications. It permits industrial engineers and research scientists to perform precise batch or process analysis in the field or in the plant. The over-all mass range of the instrument is from 2 to 80 with resolving power adequate for separation of adjacent peaks up to about mass 35. *Consolidated Electrodynamics Corporation.*

Circle number (50) on reply card.

When Specs Demand Job Matched Piping and Fittings One Call Will Do it All—B&W

The layout has been made. Erection schedules are in the planning stage. What you do now in contacting a source of supply for your alloy steel pipe fittings and flanges, can very well be one of your most important moves.

If you call on B&W, you can be assured of benefits that simplify scheduling problems. With one call to B&W—on one order—you can obtain matched pipe, fittings and flanges to meet your specific requirements. What's more—the delivery of the alloy steel pipe, the seamless welding fittings, and the forged steel flanges that make up the integrated system you desire—can be coordinated. This is just one more reason why B&W has earned the reputation and acceptance as "the natural source" for alloy pipe and fittings.

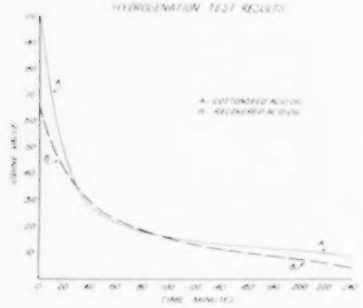
Call on Mr. Tubes at your nearby B&W Tubular Products Division District Sales Office—let him coordinate your alloy steel pipe, seamless welding fittings and forged steel flange problems. He can help you. The Babcock & Wilcox Company, Tubular Products Division, Beaver Falls, Pa.

TA-7009-PP3

Seamless and welded tubular products, seamless welding fittings and forged steel flanges—in carbon, alloy and stainless steel.

New Equipment

New Process for Fatty Acids. A modified high-pressure process for better and more economical hydrogenation of fatty acids has been developed by Process Plants Division. Process is now operating successfully in a plant designed and constructed for a leading chemical manufacturer. It is unique in that it effects the economical hydrogenation of certain difficult stocks to exceptionally low iodine values, as illustrated in the chart. This is accomplished without an appreciable increase in catalyst or hydrogen consumption, which means that more saleable product is made at a lower unit cost. Moreover, large batch sizes of 10,000 to 30,000 lb may be run. Process operates at 300-600 psi. The most economical use of hydrogen is assured by 2 unique design features: Operation in series of 2 hydrogenators and continuous, automatic control of the hydrogen being vented from the reactors. *Process Plants Division of Industrial Process Engineers.*



Circle number (51) on reply card.

Catalyst Loader. Dubbed the "Dinosaur" by cracking plant operators, catalyst loading elevator was built for C. F. Braun &

Company to be used by the Tidewater Oil Company's cracking plant in Delaware. Telescoping boom can be extended to a full height of 70 ft. Boom can be stowed in horizontal position and entire unit moved easily and conveniently from station to station. Catalyst material is fed by means of a barrel dumping device to a vibrating screen. Screen feeds to a Stephens-Adamson zipper conveyor belt which elevates the catalyst to a head pulley at the top of the boom. It is then discharged into the reactor. *Stephens-Adamson Mfg. Company.*

Circle number (52) on reply card.

Round Trace Line. Lower cost and higher efficiency of steam-traced piping is possible with ALCOA's new design in Unitrace.

Introduced in 1953, Unitrace was oval in shape. Engineers recently designed the 1-piece, steam-traced piping with a crosssection matching standard pipe in nominal sizes of 1½, 2, 3, and 4 in. New design boosts the efficiency of Unitrace by increasing the transfer of heat internally, and cutting heat-loss from external radiation. *Aluminum Company of America.*

Circle number (53) on reply card.

Low Cost X-ray. A new and more powerful type of low cost X-ray unit for portable radiographic inspection is being introduced. The Baltospot 200 features a high degree of portability. With a rated capacity of 200,000 v, the X-ray head weighs only 85 lb. Low inherent filtration puts it into the realm of an all-purpose field unit, and the range of materials it will radiograph extends from thin magnesium sheet to 3 in. of steel. Completely sealed, the X-ray head is waterproof, dustproof, weatherproof, and shockproof. Because of a simplified control panel, the Baltospot 200 does not require a trained operator. *Balteau Electric Corporation.*

Circle number (54) on reply card.

Truck Crane Handles 45 Tons. Production on a new 45 ton capacity truck crane has been started. Total weight for the unit is only 90,080 lb. For critical moving conditions, this can be reduced to 67,100 lb by removal of boom, counterweight and outrigger beams. Designated as the Koehring 445, the new truck crane can use up to a 120 ft boom. Engine delivers 214 hp at 2400 rpm. Truck has 8 speeds forward — 4 in main and 2 in auxiliary. Top speed is 31.8 mph. *Koehring Company.*

Circle number (55) on reply card.

Vertical Gearmotor. A vertical gearmotor especially for cooling tower service has been developed. Design eliminates right angle gear units, shafts, and flexible couplings. The entire tower is built of nonleaching "Chemonited" Douglas Fir, and a straddle bracing system of construction utilizes the 33 percent advantage in modulus of elasticity. Tower uses stainless steel hardware for greater corrosion resistance. *G. W. Galloway Co., Cooling Tower Division.*

Circle number (56) on reply card.

Analytical Instruments. A new 16-page catalog of laboratory analytical instruments has been published by Perkin-Elmer. Catalog describes the company's line of infrared and ultraviolet spectrophotometers, monochromators, flame photometers, vapor fractometers, as well as accessories and instrument components available for use with them. *Perkin-Elmer Corporation.*

Circle number (57) on reply card.

Laboratory Glass Catalog. Fischer & Porter has issued a new, 16-page catalog describing its line of Lab-Crest glassware, fabricated from Pyrex brand glass. Catalog 80C100 gives specifications and prices of Lab Crest precision-bore burettes in a variety of types and graduation intervals. All apparatus features F&P's Lab-Crest stopcock which utilizes a chemically-inert plug of Teflon. The self-lubricating property of the Teflon plug assures freeze-proof operation, no leakage and no danger of product contamination. *Fischer & Porter Company.*

Circle number (58) on reply card.

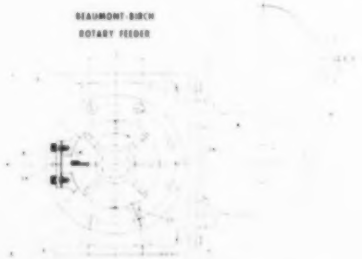
Wrench Booster. Model TD is a new general-utility tool which boosts wrench turning force 4 times. Used with standard sockets and wrenches, it provides mechanical advantage for safe, easy loosening and tightening of heavy threaded parts. Application includes assembly and disassembly of high-torque threaded parts in transportation equipment, heavy plant or marine machinery and large piping systems. *X-4 Corporation.*

Circle number (59) on reply card.

New Lube Oil Additives. Two new viscosity index improvers for lubricating oils are being offered. Called Omavis 10 and 20, the additives are outstanding in their resistance to shear breakdown. They thicken the oil less for a given viscosity index level than do similar products, thus permitting wider latitude in compounding as well as reduced use of additive. *Industrial Chemicals Division of Olin Mathieson Chemical Corporation.*

Circle number (60) on reply card.

Feeder Operates at Pressures. Compact, periphery sealed, 8 pocket rotary feed unit of the air lock type for feeding bulk chemicals and other materials at differential pressure to 25 psi has been developed. Design features are the mating,



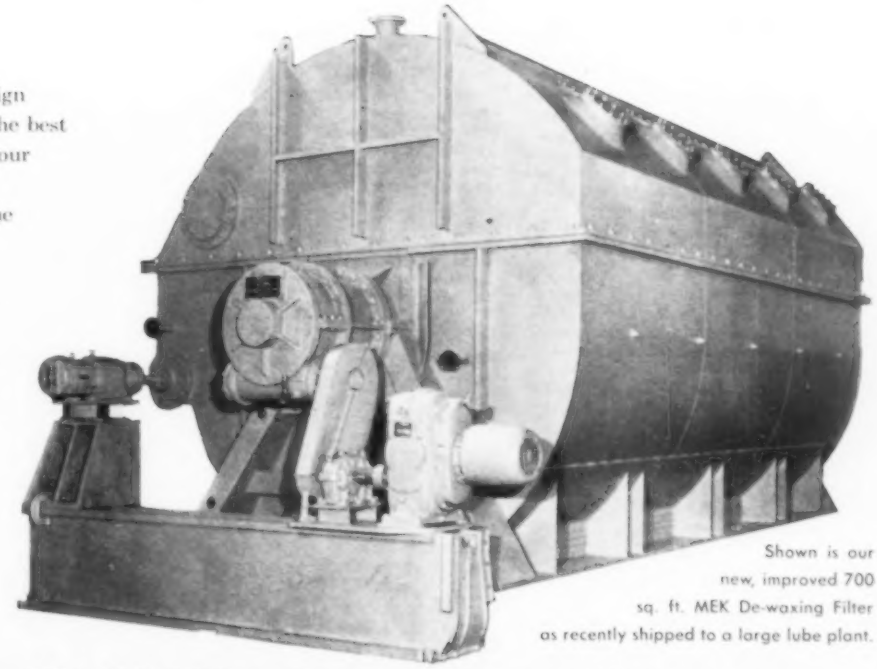
V-shaped, floating, Teflon seal rings that extend service life. Adjustable tips on the rotor blades are available in nylon, Teflon, Neoprene, rubber, stainless steel or monel. Called the STT type, it is available in 4, 6, 8 and 10-in. sizes combined with a new Reeves Vari-Speed Motordrive with ratios up to 10 to 1. *Beaumont Birch Co.*

Circle number (61) on reply card.

De-waxing Filters...

To fit your requirements!

Goslin-Birmingham manufacturing and design know-how assure you the best de-waxing filter to fit your requirements, whether for the MEK or propane process. G-B has the engineering and fabricating experience gained in the manufacture of more de-waxing filters than any other producer . . . by many times the largest volume in the industry.



Shown is our new, improved 700 sq. ft. MEK De-waxing Filter as recently shipped to a large lube plant.

Call or Write G-B for engineering consultation at no obligation.

GOSLIN-BIRMINGHAM MANUFACTURING CO., INC.

BIRMINGHAM • ALABAMA

NEW Literature

For more information on items described here in brief, use the handy reply card and circle the corresponding numbers

Spun Steel Tubes. A 64-page catalog describing and illustrating ACIPCO's centrifugally spun steel tubes has been published. Included is information on facilities for production of the tubes, and also technical data and information solving tubular product problems. Tubes are used as hydraulic cylinders, marine equipment, high quality engineering parts, and for hundreds of industrial uses. *American Cast Iron Pipe Co.*

Circle number (62) on reply card.

General Electric Heaters and Devices. The new 1957 catalog of General Electric heaters and heating devices includes information on such new products as redesigned cartridge heaters, miniature soldering irons, aluminized steel sheath strip heaters, and new ratings and configurations of finned tubular heaters. Also described are the new ceramic-to-metal and plastic resin hermetic seals.

Designated bulletin GEC-1005H, the publication includes data, specifications and operating information. *General Electric Company.*

Circle number (63) on reply card.

High Temperature Equipment. A reprint is now available from the Tubular Products Division of The Babcock & Wilcox Company on the paper "High-Temperature Problems in Process Plants." The report discusses the use of steel and its various alloys, and the mechanical and physical reactions of the materials under various temperature and corrosive environments. *The Tubular Products Division of The Babcock & Wilcox Company.*

Circle number (64) on reply card.

Valves. A bulletin showing 3 types of valves has been published by Fluidal Valves, Inc. Information concerning service, pressure rating, and operating temperature of the valves is included with a description of the performance of each. Valve size and pressure drop comparison is also shown. *Fluidal Valves, Inc.*

Circle number (65) on reply card.

Protective Maintenance Booklet. A brochure on the application of protective coatings and linings, citing an actual case history explaining how metallizing saved a semi-chemical pulp digester from reduced operating status, has been published by Protective Coatings Division, Metalweld, Inc. It also gives data on sand and grit blasting as well as fabrication and major repairs of process equipment. *Protective Coatings Division, Metalweld, Inc.*

Circle number (66) on reply card.

Corrosion-Proof Motors. "Corrosion-Proof from Core to Cover," a new 8-page pamphlet, describes Reliance corrosion-proof motors, designed for application in any corrosive atmosphere. Photographs and word-pictures illustrate the motors. *Reliance Electric and Engineering Company.*

Circle number (67) on reply card.

Water Treatment Plants. A new technical article on automation of water treatment plants has been published by Graver Water Conditioning Co. Specific case histories on automation are presented, pointing out problems involved and methods of solution, and flow diagrams of plants are shown to allow the reader to understand the problem and solution.

Article also includes important classification breakdowns and a chart of various types of demineralizers available, their application and advantages. *Graver Water Conditioning Co.*

Circle number (68) on reply card.

Control Systems. A new booklet, "High-Speed Analog Computers, Key to Rapid System Development," answers questions concerning automation and the development of control systems for industrial and military applications. In question-and-answer style the booklet defines certain types of computers and summarizes the applications of each. The virtues and limitations of high-speed analog computers, as compared with real-time computers, are then discussed, using the GPS computer as an example. *GPS Instrument Company, Inc.*

Circle number (69) on reply card.

ASARCO Pictorial Review. American Smelting and Refining has made available a 28-page, 4-color booklet entitled, "ASARCO Products and Processes." Booklet, containing more than 30 color and black and white photographs, is a pictorial review of ASARCO's mining, smelting, refining and research operations. Also, detailed maps show the locations of these world-wide company operations, as well as sales offices and other facilities. *American Smelting and Refining Company.*

Circle number (70) on reply card.

Science and Showmanship. Vol. 25, No. 5 of "The Laboratory" has been published by instrument manufacturer Fisher Scientific. Feature story, Science and Showmanship, covers the heyday of 19th century science, when society women paid $100 to hear a lecture on chemistry by Sir Humphry Davy; when, on a single day, 11,696 persons trooped in to see scientific apparatus at a London exhibit, and when Darwin was buried with High Church ceremony at Westminster Abbey. *Fisher Scientific Company.*

Circle number (71) on reply card.

Generator Coolers. A new bulletin describing the most recent developments in coolers for generator windings has been prepared by The Griscom-Russell Company, a subsidiary of General Precision Equipment Corporation. Bulletin 1200 describes the design and construction of G-R K-Fin Coolers, manufactured for both air and hydrogen circulated through the generator windings in a closed system. The application of each type of unit is illustrated and explained. *The Griscom-Russell Company.*

Circle number (72) on reply card.

Revised Condensed Catalog. A completely revised and condensed 28-page catalog (C-5000, Rev. 8) covering Rockwell meters, regulators, and valves has been introduced by Rockwell Manufacturing. Outstanding new features of the catalog include photo-illustrated descriptions of the recently introduced Rockwell telapilot — with power pilot loading by remote control — and the Hypregun, a light compact, efficient air-operating valve lubricant gun. The catalog also includes completely revised Nordstrom valve specifications. *Rockwell Manufacturing Company.*

Circle number (73) on reply card.

Aluminum Jacketing. Aluminum jacketing for insulated lines is described in a new bulletin and folder released by Aseeco. It describes application methods, specifications of the jacketing, and offers complete specifications for use in ordering. Shipped in individually packaged rolls with or without moisture barrier, jacketing comes in thicknesses of .006, .016, and .020 in. *Aseeco, Inc.*

Circle number (74) on reply card.

Mist Eliminators. The new "Schuylernit" manual shows the design, application and performance of Schuylernit mist eliminators in chemical and petroleum process vessels. It also explains and solves many liquid entrainment problems in scrubbers, absorbers, evaporators, knock-out drums, cracking towers and distillation equipment. *Schuyler Manufacturing Corp.*

Circle number (75) on reply card.

Processing. Two new brochures are released by Goslin-Birmingham on heavy duty vessels, mechanical equipment, and process equipment. Equipment includes evaporators, vacuum pans, vacuum crystallizers, vacuum filters, pressure filters, flakers and heat exchangers plus condensers. *Goslin-Birmingham Manufacturing Co., Inc.*

Circle number (76) on reply card.

Planning in Space. "Visual" Plant Layouts has published a brochure introducing a planning cube to be used by chemicals and processing industries. Planning cube simplifies planning problems by providing the means of making a 3-dimensional layout of any cube problem. Available in kit form, the cube is made of aluminum and polyester plastic. *"Visual" Plant Layouts, Inc.*

Circle number (77) on reply card.

The Harte System. A new 6-page booklet featuring a complete engineering service of the John J. Harte Company has just been published. The Harte System provides a unique modern approach to growth problems. It illustrates a comparison between traditional procedure and the Harte System, application of the system, and a few examples of the company's "know-how." *John J. Harte Company.*

Circle number (78) on reply card.

Metal Containers. A 6-page brochure has been released by Southern States Iron Roofing describing their many standard containers and special drums and casings, which are tailor made to individual specifications. All drums, both standard and special, are tested in various ways for leakage. *Southern States Iron Roofing Co.*

Circle number (79) on reply card.

MAJOR PIPELINES EVERYWHERE

are served better by the very best...
Walworth Lubricated Plug Valves

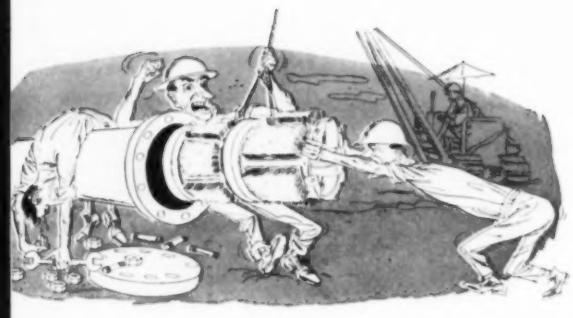
Walworth Cast Steel Lubricated Plug Valves enjoy a long record of successful service on pipelines the world over. In design, construction and performance they stand unsurpassed.

Other Walworth products include Gate, Globe, Angle and Check Valves in a wide range of types and sizes for the oil and gas industries. Sold by distributors in principal centers throughout the world.

WALWORTH

60 East 42nd Street, New York 17, New York

SUBSIDIARIES: ALLOYCO ALLOY STEEL PRODUCTS CO. CONOFLOW CONOFLOW CORPORATION GROVE GROVE VALVE & REGULATOR CO.
SW SOUTHWEST FABRICATING & WELDING CO., INC. MH M & H VALVE & FITTINGS CO. WALWORTH COMPANY OF CANADA, LTD.

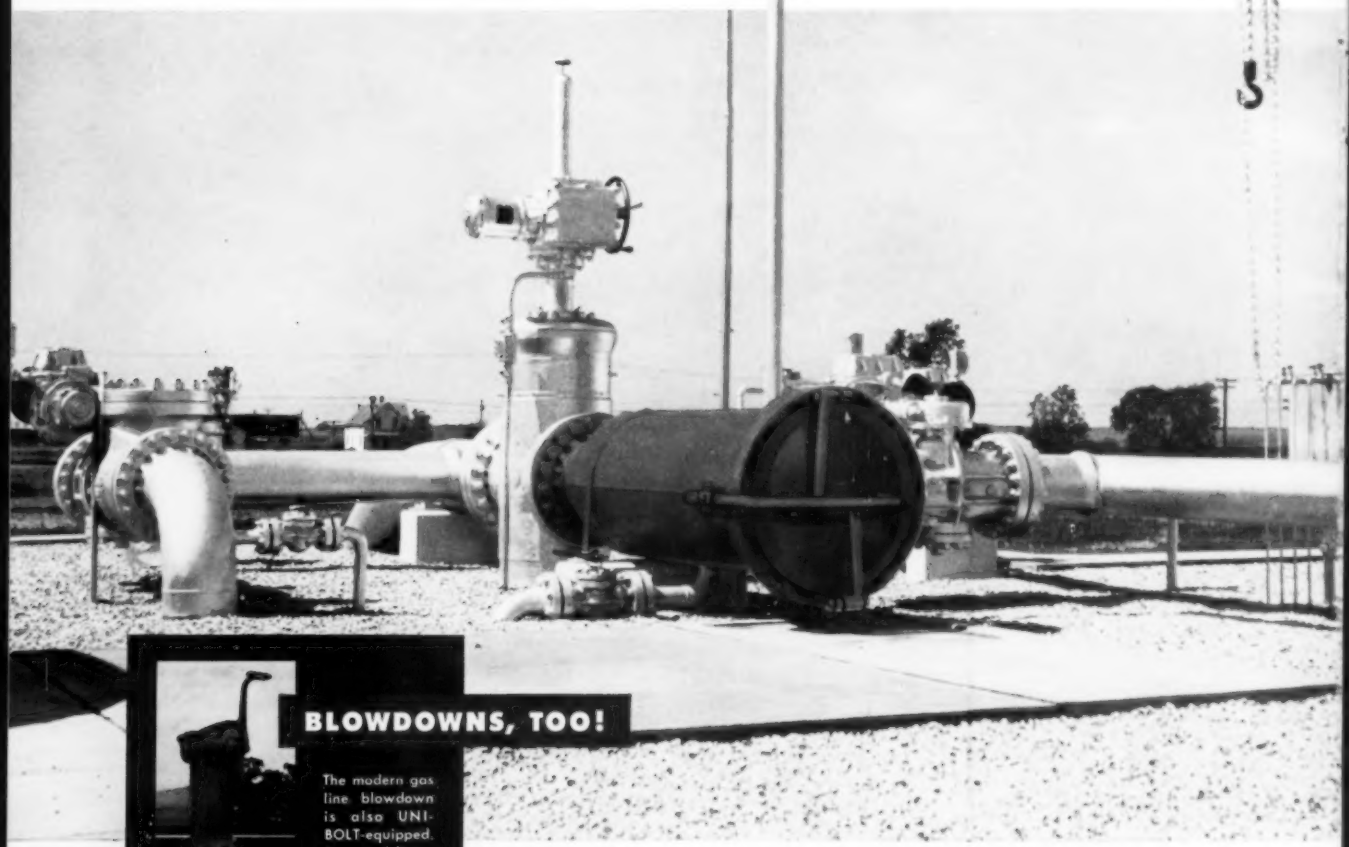


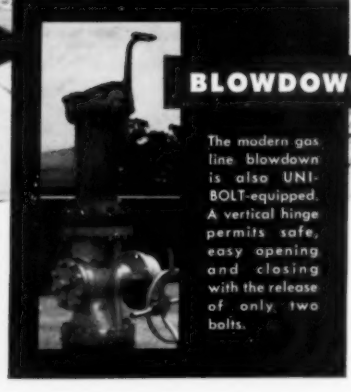
Don't Get Caught With An Old Fashioned Trap!

UNIBOLT SCRAPER TRAPS

Are So Safe, Easy, And Trouble-free

No need to knock yourself out opening and closing scraper traps at pigging time. Release two bolts and the UNIBOLT closure swings open on a sturdy hinge . . . like a gate. Use an over-size barrel so the pig will slip in easily and let line pressure do the heavy work. No time-consuming bolting and unbolting. No heavy flanges to lift off and on. Nothing to fall on workmen. A self-sealing resilient gasket makes a tight seal every time and seldom requires replacement. UNIBOLT Pipeline Couplings, with or without closures, regular or hinged, are available in sizes up to 42-inch and in ASA 150 Lb. to ASA 900 Lb.





BLOWDOWNS, TOO!

The modern gas line blowdown is also UNIBOLT-equipped. A vertical hinge permits safe, easy opening and closing with the release of only two bolts.

THORNHILL
P. O. BOX 1184

UNIBOLT

CRAVER CO.
HOUSTON, TEXAS

PIPELINE DEVELOPMENTS

★ ★ ★

Roundup of Planned and Proposed Construction

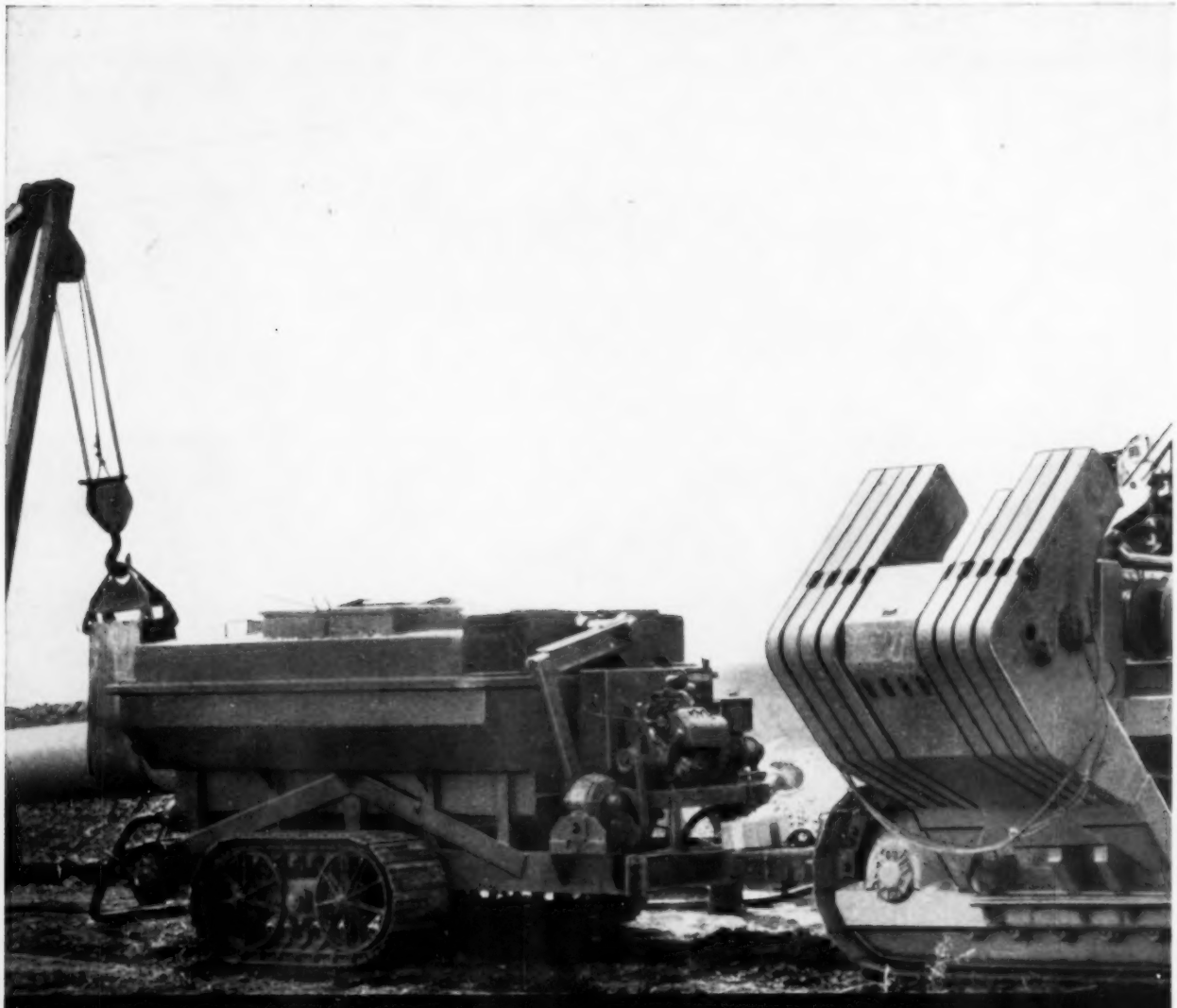
The following tables list the company, mileage, pipe size, and location of proposed pipeline projects — crude, products, and natural gas — reported to *The Pipeline Engineer*. Company addresses are given when known.

CRUDE LINES

Name of Company	Miles	Size	Location
Atlantic-Cities-Service-Continental-Gulf-Phillips-Texas-Sinclair	Approx 385	26	Midland, Texas, area to Houston
Cape Pipe Line Company Philadelphia, Pennsylvania	200	—	Large diameter from Delaware Bay to Greater Philadelphia area refineries
Four Corners Pipe Line Company	750	8, 12, 16	Farmington, New Mexico, area to Los Angeles, California
Lakehead Pipe Line Company, Inc. Toronto 1, Ontario, Canada	80	26	Loop from Clearbrook, Minnesota, to Superior, Wisconsin
North-West Oil Pipelines Company	210	—	Wilhelmshaven, on the North Sea, to industrial Ruhr area of West Germany
Northwest Pipe Line Corporation Salt Lake City, Utah	350	8–10	Four Corners area to Salt Lake City, Utah
Offshore Gathering Company Houston, Texas	364	20	Gulf of Mexico from Sabine Pass to Mississippi River
Rangeland Pipe Line Company Calgary, Alberta, Canada	450	—	Sylvan Lake Area to Sundre (Central Alberta)
Royal Dutch Shell Group and Others The Hague, Netherlands	870	30	Marseille, France, to Rotterdam, Holland, and Antwerp, Belgium
Royal Pipe Lines, Ltd. Regina, Saskatchewan, Canada	288	Var.	Cantuar area fields to Glenavon
Salt Lake Pipe Line Company Salt Lake City, Utah	100	10	Additions to Rangely, Colorado-Salt Lake City line
Shamrock Oil and Gas Company Amarillo, Texas	35	6	5000-6000 bbl per day line from McKee station, Moore County, Texas, to Hansford and Ochiltree counties
Sinclair Pipe Line Company Independence, Kansas	150	20	Teague to Houston, Texas
Texas-New Mexico Pipe Line Company Houston, Texas	515	16	Extension from Jal, New Mexico, pump station to Four Corners area
Trans-Border Pipe Line Company	110	—	Skagway, Alaska, to Whitehorse, Yukon Territory

PRODUCTS LINES

Name of Company	Miles	Size	Location
El Paso Natural Gas Company El Paso, Texas	96.0	8	Gallup to Blanco Plant, New Mexico
	290	Var.	Additional line on existing system in Texas, New Mexico, Arizona
El Paso Natural Gas Products Company	250	6	Odessa, Texas, to El Paso
Equitable Gas Company and Subsidiaries Pittsburgh, Pennsylvania	100	4–5	Maytown, Kentucky, to Institute, West Virginia
Great Lakes Pipe Line Company Kansas City, Missouri	84	8	Eau Claire, Wisconsin, laterally from a point on existing lines south of St. Paul, Minnesota
	68	12	To Chicago from juncture of Great Lakes' lines with Badger system. Will supplant existing 6-in. line
	140	8	Connect terminals between Minneapolis and Superior, Minnesota
	34	12	Tulsa to Barnsdall, Oklahoma loop
	14	8	Coffeyville to Independence, Kansas
	11	8	Line between point near Donahue, Iowa, pump station to Mississippi River terminal at Bettendorf, Iowa
Northwest Pipeline Corporation Salt Lake City, Utah	350	8–10	Four Corners to Salt Lake City, Utah
Ohio Oil Company Findlay, Ohio	—	—	Common carrier line from Wood River, Illinois, to Chicago
	—	—	Connecting line from Robinson, Illinois, refinery to new line
Salt Lake Pipe Line Company Salt Lake City, Utah	80	8	Additions to Boise, Idaho to Pasco, Washington line
Service-Continental-Sinclair-Phillips	550	—	Salt Lake City, Utah, to Spokane, Washington
Texas Eastern Transmission Corporation Shreveport, Louisiana	1168	16–20	Conversion of "Little Inch" between Beaumont, Texas, and Moundsville, West Virginia
Union Oil Company of California	815	—	Shale Oil Plant, Rifle, Colorado, to Los Angeles area
Winnipeg & Central Gas Company Winnipeg, Manitoba, Canada	210	6	U. S.-Canadian border to Winnipeg



KEEP PIPE HANDLING COSTS DOWN . . .

Torque converter drive . . . matches power and speed to job requirements automatically . . . cushions entire power train and mounted equipment.

Double-reduction final drive and smooth underside . . . give extra clearance for working on irregular terrain.

1,000-hour lubrication intervals for truck wheels . . . eliminate daily greasing . . . convert maintenance time to working time.

One-piece steering clutch and final drive housing . . . insure perfect gear alignment, long life.

Unit construction . . . major assemblies can be removed without disturbing adjacent parts . . . makes service simple, fast.

Allis-Chalmers, Construction Machinery Division, Milwaukee 1, Wisconsin.

Just a few of the basic advantages that help this Allis-Chalmers Tractor-Tractomotive side boom

ALLIS-CHALMERS ***. . . crawler tractors***

..with help like this!

Internal expanding brakes . . . protected from dirt and water . . . provide positive control of load and boom line drives.

Safety link extendable counterweights . . . controlled hydraulically and mounted high for maximum clearance.

Convenient controls . . . easy operating, positive, conveniently located.

Quick-on, quick-off sectional boom frames . . . pin-connected for fast attachment or removal for transport.

Simplified transmission . . . one lever switches boom or load line from raise through neutral to power down—no gear shifting necessary.

Tractomotive Corporation, Deerfield, Illinois.

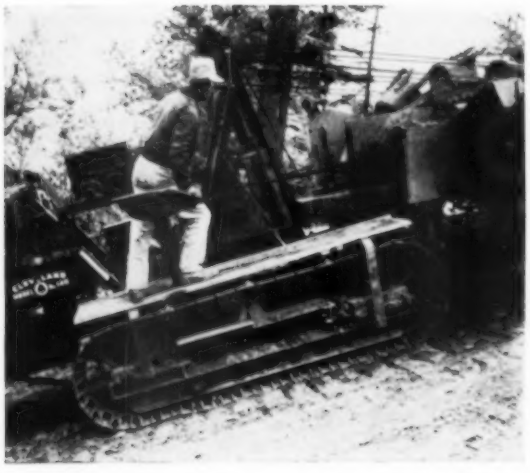
combination speed output... give you bigger profits. Now is the time to have them working for you.

TRACTOMOTIVE ***...side booms***

GAS LINES

Name of Company	Miles	Size	Location
Arkansas Louisiana Gas Company	300	—	Main and gathering lines Louisiana-Texas Gulf Coast
Andes Pipeline Corporation	500	12	Villamontes, Bolivia, to Antofagasta, Chile
Cities Service Oil Company	70	—	Gas gathering system on the Roberts Ranch, Midland, Texas
Bartlesville, Oklahoma	115.6	Var.	Montgomery, Allen, Anderson, Franklin, Miami, Johnson, Wilson counties, Kansas
Coastal Transmission Corporation	574	22–26	McAllen, Texas, to Baton Rouge, Louisiana
Dallas, Texas	414	Var.	Gathering lines in Rio Grande Valley, Texas
Colorado Interstate Gas Company	345	30	Kit Carson, Colorado, to Beatrice, Nebraska
Colorado Springs, Colorado	100	24	Springfield to Pueblo, Colorado
	24	24	Greenwood to Panhandle-Kit Carson loop
	109	20	Loop from Fourway, Texas, to Springfield, Colorado
	106	24	Loop from Springfield to Kit Carson, Colorado
	10	16	Keyes field, Oklahoma, to mainline
	6	10	Tablerock field, Wyoming, to mainline
	12.0	12–22	Additions in Texas Panhandle fields
El Paso Natural Gas Company	20.5	30	Loops to existing Permian-San Juan mainline from Bluewater station to San Juan mainline in McKinley County, New Mexico
El Paso, Texas	8.3	26	Loops to California mainline in Yuma County, Arizona
	28.5	30	Field transmission line in San Juan Basin, New Mexico
	78.8	18	Field line from Carson County, Texas, to Moore County, Texas
	22.5	20	South Andrews field booster station to plant
	8.5	16	Shell plant to Goldsmith station
	290	—	To deliver additional gas to three California customers. New gas to come from San Juan Basin and Panola and Permian Basin fields in Texas.
Houston Texas Gas & Oil Company	942.6	12–30	Baton Rouge, Louisiana, to Miami, Florida
Houston, Texas	682	—	Laterals to serve Florida to distributors, industrial users
Kansas-Nebraska Natural Gas Company	61.3	Var.	Gathering lines from Camerick field to Liberal, Kansas
Phillipsburg, Kansas	10	10	Grand Island to Fullerton, Nebraska
	10	8	Loop from Grand Island to Fullerton, Nebraska
	11.5	12	Replacement from Scott City to Oakley, Kansas
	1.2	6	Additions to system in Nebraska
	9	8	Lexington to Central Nebraska Public Power Electric Plant
	14	16	Replacement from North Platte to Maxwell, Nebraska
Michigan Wisconsin Pipe Line Company	31	4–6	Looping in Michigan and Indiana
Detroit, Michigan			
Midwestern Gas Transmission Company	1112	12–24	Mainline from U. S. Canadian border near Emerson, Manitoba — Noyes, Minnesota, to Portland, Tennessee
	648	3–18	Laterals of mainline to serve communities in Minnesota, North Dakota, and Wisconsin
Natural Gas Pipe Line Company of America	349	20–26	Jack and Wise counties to Fritch, Texas
Chicago, Illinois	38	36	Joliet to Elgin, Illinois
	405	36	Beaver County, Oklahoma, to Joliet, Illinois (loops)
	25	—	Gathering line from Quinduna field, Roberts County, Texas, to point on existing line
	91	30	Loops in Nebraska, Kansas, Oklahoma
Northern Natural Gas Company	28	24	Ogden to Redfield storage area, Iowa
Omaha, Nebraska	**168**	20	St. Paul-Minnesota to Duluth, Minnesota, and Superior, Wisconsin
	100	20–24	Savannah Creek field, Alberta, to Alberta-Montana border near Cardston, Alberta
Northern Plains Natural Gas Company (subsidiary of Northern Natural Gas Company)	1100	26	Alberta-Montana border to Minneapolis, Minnesota
Omaha, Nebraska			
Offshore Gathering Company	364	30	Offshore gas line in Gulf of Mexico from Sabine Pass to Mississippi River
Houston, Texas			
Pacific Gas & Electric Company	200	12	Glenn and Tehama counties to Eureka and Arcata, California
San Francisco, California			
Pacific Lighting Gas Supply Company	80	30	Coles Levee to Newhall, California
Los Angeles, California	2.1	16–20	Potrero to Newhall, California
	2.8	16	Lines in East Whittier, California
Tennessee Gas Transmission Company	100	—	New gathering lines in Texas and Louisiana
Houston, Texas	**557**	30	Mississippi River Delta south of New Orleans to Portland, Tennessee
	120	12,20,26	Kinder, Louisiana, south 68 miles into Gulf of Mexico
	332	24–30	Loops in Kentucky, West Virginia, Pennsylvania, Tennessee
	76	24	Coudersport, Pennsylvania, to Buffalo, New York
	299	Var.	Adding to existing systems in Ohio, Pennsylvania, Kentucky, Texas and Louisiana
Texas Eastern Transmission Corporation	10	12	Loop from Broadaxe Junction to Levick Street, Philadelphia, Pennsylvania
Shreveport, Louisiana	6	12	Loop from Broadaxe Junction to Conshohocken, Pennsylvania
	5	10	South Plainfield to Highland Park, New Jersey
	96.5	30	Loops Kosiusko, Mississippi to Uniontown, Pennsylvania
	40	—	Lateral supply lines
Texas-Illinois Natural Gas Pipeline Company	59	20	Joliet to Volo, Illinois
Chicago, Illinois			
Trans-Canada Pipe Lines, Ltd.	1675	30–34	Winnipeg to Montreal and laterals
Calgary, Alberta, Canada			
Transcontinental Gas Pipe Line Corporation	28.5	16	Gathering system in Gulf of Mexico, off Louisiana Coast
Houston, Texas	229	—	Gathering laterals in Texas
	42	36	Loops on existing lines
	16	30	Additional mainline looping
Westcoast Transmission Company, Ltd.	174	30	Line from Savannah Creek gas field, Alberta, to existing system

Cleveland 140 digs through rocky New Hampshire hills



"...exceeds wildest expectations"

"We got trench with our Clevelands where we thought it would be impossible," says H. J. Burns of Hallen Construction Co., Island Park, N. Y., about a recently completed pipeline job for the Granite State Transmission Co., between Exeter and Somersworth in the rugged New Hampshire hills. The Hallen spread cut through numerous swamps and terrain strewn with boulders and choked with frequent outcroppings of rock.

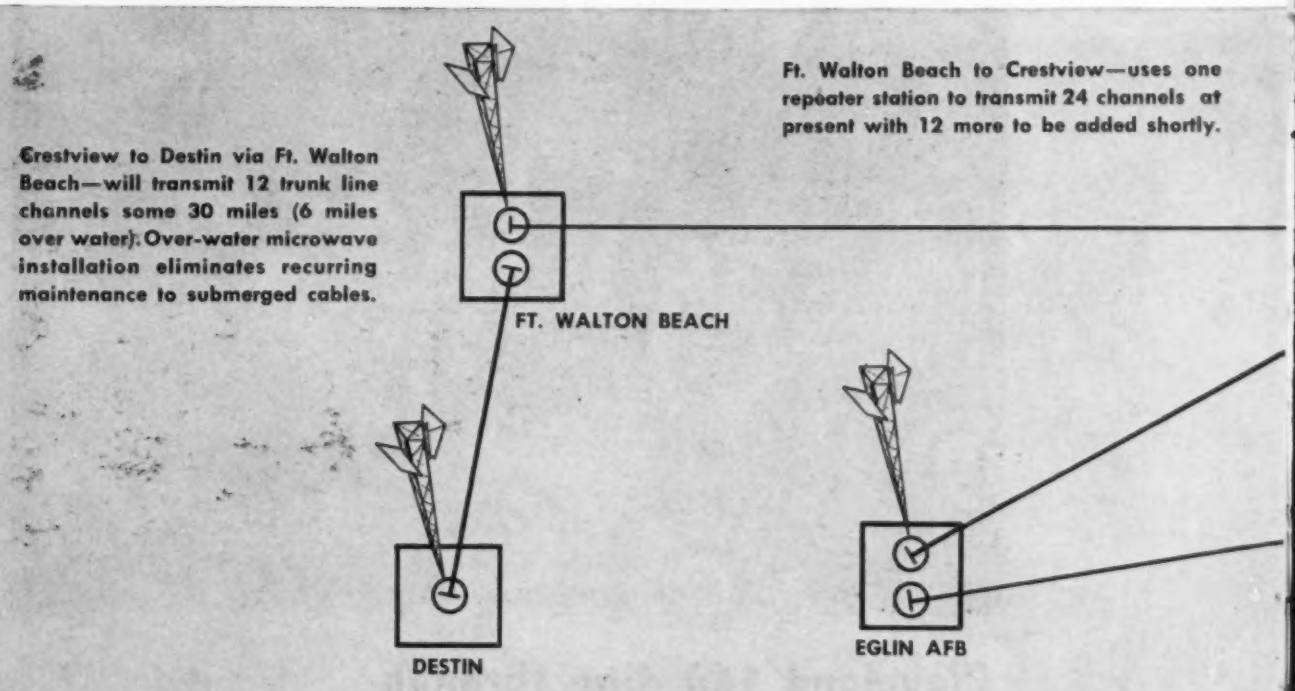
"Our Cleveland 140 cut 24 miles of our 30-mile section —dug everything except the deepest swamps and solid ledge rock. It dug through shale and even handled boulders up to 6 and 8 cubic yards. Even in the toughest going the 140 never fell below 1,700 feet of trench per day and averaged 2,200 feet per day for the whole job."

Good Everywhere

THE CLEVELAND TRENCHER COMPANY

20100 ST. CLAIR AVENUE • CLEVELAND 17, OHIO

More Philco Microwave Ordered by


Crestview to Destin via Ft. Walton Beach—will transmit 12 trunk line channels some 30 miles (6 miles over water). Over-water microwave installation eliminates recurring maintenance to submerged cables.
Ft. Walton Beach to Crestview—uses one repeater station to transmit 24 channels at present with 12 more to be added shortly.
FT. WALTON BEACH
DESTIN
EGLIN AFB

Progressive Southeastern Telephone Company Repeatedly Specifies Philco Microwave In Dynamic Expansion Program

On the basis of proven reliability, economy and efficiency, Southeastern Telephone Co. selected Philco Microwave Equipment . . . has it in operation . . . and is installing more.

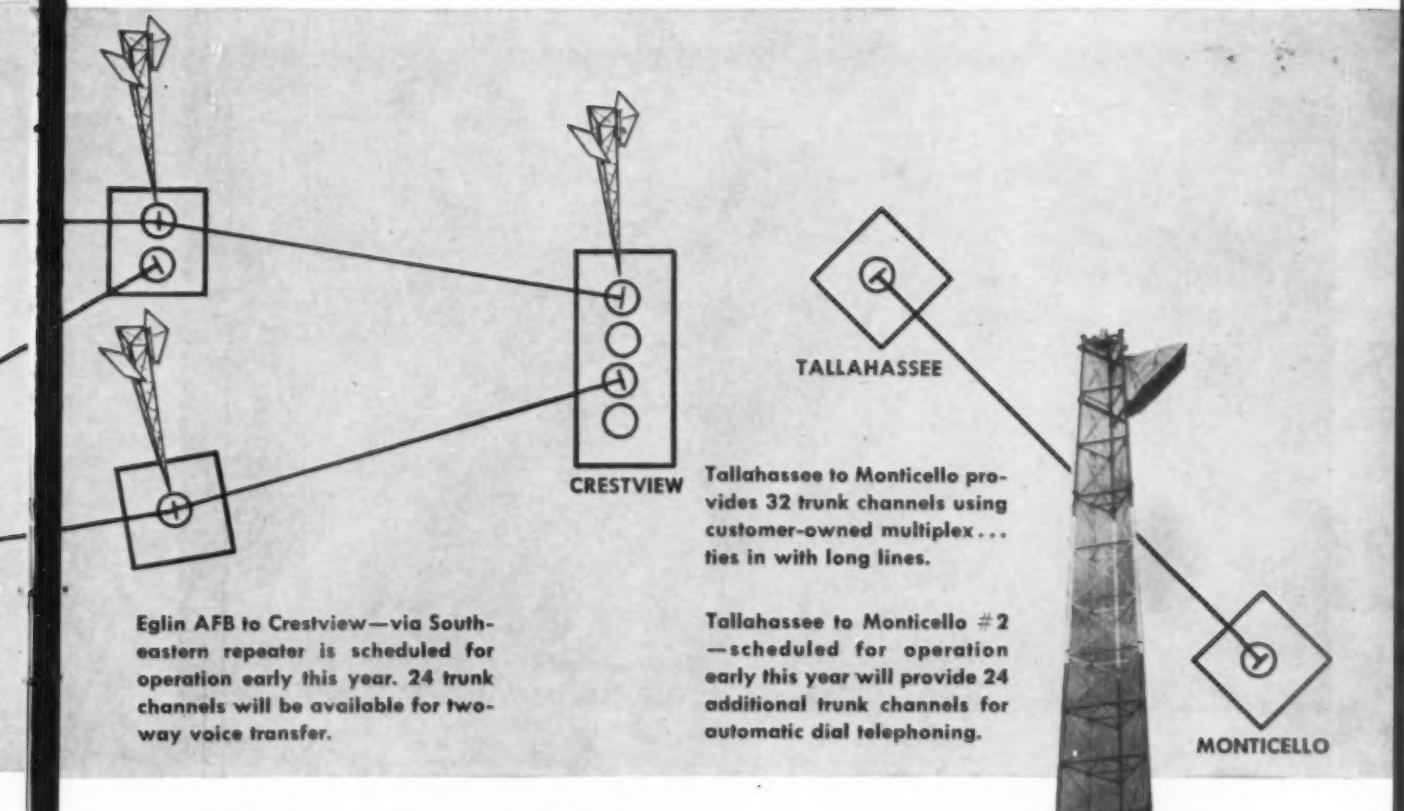
Multiple voice channeling, plus completely automatic dial system switching eliminate the need for manual switchboards at Destin and Ft. Walton Beach. Fallen transmission lines and service interruptions due to turbulent weather are a thing of the past. The need for submerged cable in the 6-mile over-water hop from Destin to Ft. Walton Beach has been eliminated entirely.

PHILCO® CORPORATION

GOVERNMENT AND INDUSTRIAL DIVISION

Philadelphia 44, Pennsylvania • In Canada: Philco Corporation of Canada Limited, Don Mills, Ontario

Southeastern Telephone Company!



Eglin AFB to Crestview—via Southeastern repeater is scheduled for operation early this year. 24 trunk channels will be available for two-way voice transfer.

Tallahassee to Monticello provides 32 trunk channels using customer-owned multiplex . . . ties in with long lines.

Tallahassee to Monticello #2 —scheduled for operation early this year will provide 24 additional trunk channels for automatic dial telephoning.

Linking its central toll center at Crestview to *Ft. Walton Beach, Eglin AFB* and *Destin* with low cost, automatic dial telephone service, Southeastern Tel. operates a network of Philco multiple-channel microwave trunk line carriers. Multiple trunkline switching at Destin and Ft. Walton Beach centrals is completely automatic.

The biggest mistake is the one you can't see!

As an experienced pipeline man, you'll have little trouble spotting four obvious "errors" in this picture*. But the *biggest* and most *costly* error you can make in pipeline construction is to gamble on unproven or "economy" types of pipeline protection.

Sure, you can buy "protection" that will save you a few first-cost dollars. But wait until you start paying the bills for excessive cathodic protection!

On line after line, in marshlands and mountains, tough, durable *Pitt Chem* Coal Tar Enamels have *proved* their superior ability to resist soil stress and water absorption, the two pitfalls of "economy" coatings. It's the kind of protection that gives you maximum insurance against high maintenance cost.

When you specify *Pitt Chem* you get assured quality, for *Pitt Chem* Coal Tar Enamels are manufactured to rigid, *published* specifications, from highest grade materials.

How can we help you! Send us the details of your coating problem.

*Operating from left side of ditch; man standing on line; man in ditch under line traveling machine; loop in "Hoosier" pole.

PITT CHEM® TAR BASE ENAMELS

- Standard Grade
- Modified Grade
- Plasticized Grade
- Hotline
- Cold Applied Tar Base Coatings

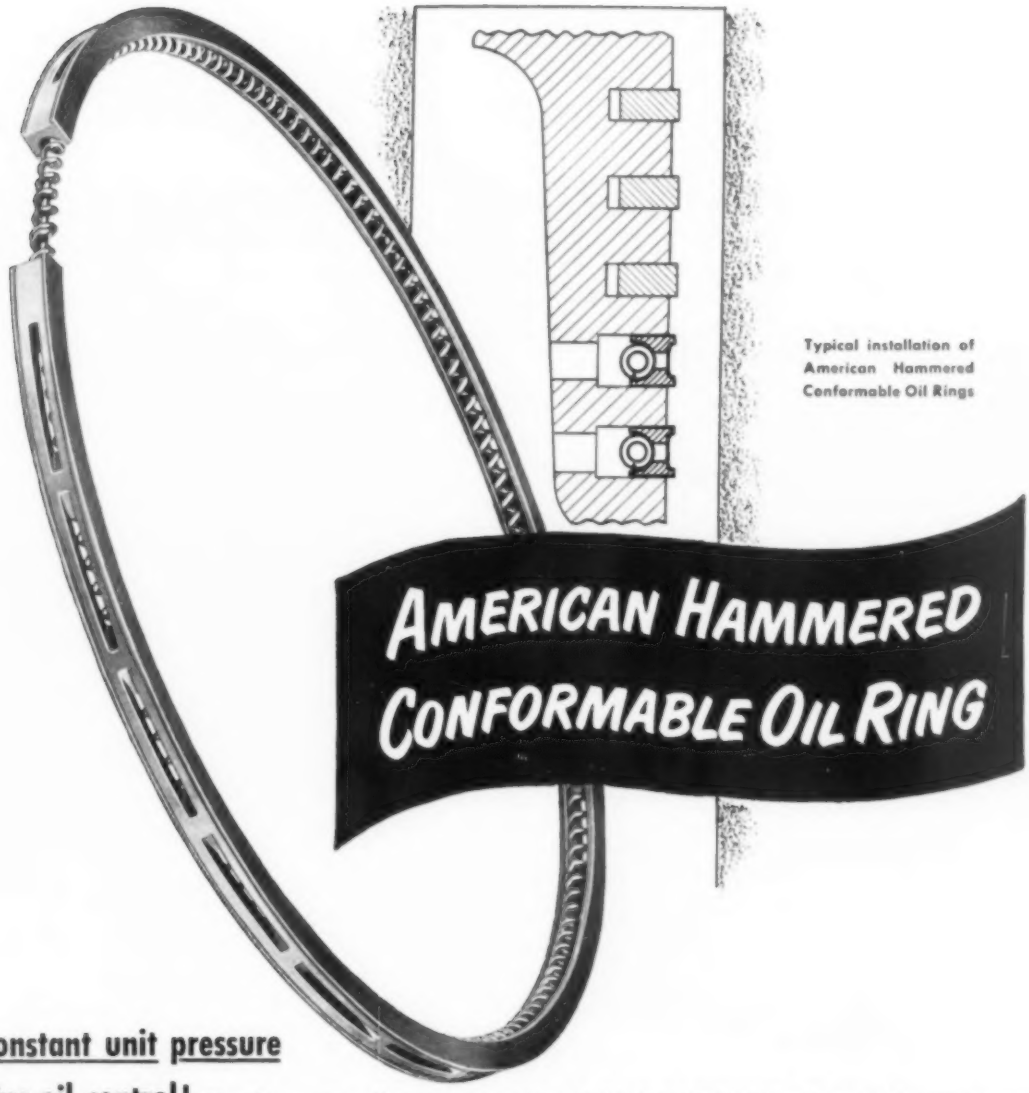
PROTECTIVE COATINGS DIVISION

PITTSBURGH COKE & CHEMICAL CO.

Grant Building • Pittsburgh 19, Pa.

WSW 6587

COAL CHEMICALS • PROTECTIVE COATINGS • PLASTICIZERS • ACTIVATED CARBON • COKE • CEMENT • PIG IRON



Typical installation of American Hammered Conformable Oil Rings

AMERICAN HAMMERED CONFORMABLE OIL RING

Insures constant unit pressure for positive oil control!

You keep your oil consumption down when you install Koppers American Hammered Conformable Oil Rings! This service-tested piston ring conforms readily to meet cylinder distortion because its flexible cast iron member is pressed outward by an abutment type spring which exerts uniform radial pressure around the entire circumference.

Narrow bearing surfaces on either side of the channel give the ring a uniform unit pressure on the cylinder, enabling it to seat promptly and assuring maximum removal of excess oil throughout its lifetime. And the Conformable Oil Ring has a longer useful life because its low spring rate and uniform lands result in negligible changes in pressure as the ring wears.

Easily installed, it is ideal for both 2-cycle and 4-cycle Diesel & Gas engines; comes in 4" to 25" diameters with a minimum width of ¼". Write, wire or phone us today for full information on how the Conformable Oil Ring can improve *your* operation . . . or for expert help in *any* piston or sealing ring problem. KOPPERS COMPANY, INC., *Piston Ring Dept.*, 1702 Hamburg Street, Baltimore 3, Maryland.

KOPPERS

METAL PRODUCTS DIVISION • KOPPERS COMPANY, INC. • Baltimore, Maryland

This Koppers Division also supplies industry with Fast's Couplings, Aeromaster Fans, Koppers-Elex Electrostatic Precipitators and Gas Apparatus.

Engineered Products Sold with Service

AMERICAN HAMMERED *Industrial Piston Rings*

KOPPERS COMPANY, INC., *Piston Ring Dept.*, 1705 Hamburg Street, Baltimore 3, Md.

Gentlemen: Please send me full information on your Conformable Oil Ring.

Name .....

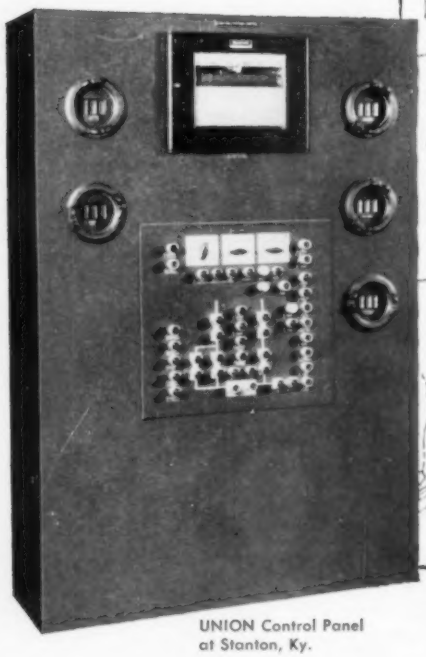
Company .....

Address .....

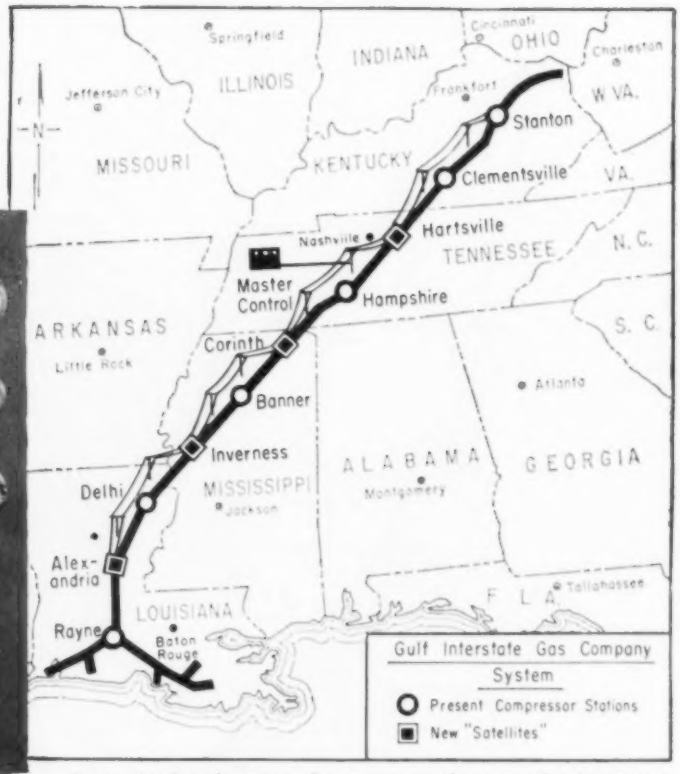
City ..... Zone ..... State .....

PIPELINE AUTOMATION PAYS!

Gulf Interstate's unattended "satellite" station shows how UNION C.T.C. lowers costs with safety and reliability.



UNION Control Panel at Stanton, Ky.



Construction is under way on four new engine-driven centrifugal compressor stations. All will be remotely controlled unattended "satellites." Operations will be directed from a UNION master control panel near the center of the system.

The Gulf Interstate Gas Company's "satellite" station at Stanton, Kentucky provides most economical and safe operation, according to Mr. R. Lo Chiano, assistant chief engineer at Gulf Interstate.

The Stanton station is remotely controlled from Clementsville, Ky., 90 miles away, through a UNION Centralized Transport Control System and has been on completely *unattended* operation since June 1956. This system is unique because it provides remote control and indications for a turbocharged engine driving a centrifugal gas compressor . . . the first installation of its kind. Large savings result because the operator at the master station can change the set point on the discharge pressure controller and start and stop the engine at Stanton.

Another important saving is obtained because the UNION C.T.C. System uses only one leased line circuit to transmit all the controls, indications and telemetering data. The control system used permits the use of the lowest-cost circuit. This installation was "custom engineered" using standard UNION components to meet the particular requirements.

The unattended station is definitely successful. There have been no false shut-downs that were not man made. With this in mind, future stations are being patterned after the one at Stanton.

Write for further information on UNION C.T.C. for all types of pipelines, gathering systems or tank farms. Ask for Bulletin 1052.

GENERAL APPARATUS SALES

UNION SWITCH & SIGNAL

DIVISION OF WESTINGHOUSE AIR BRAKE COMPANY

PITTSBURGH 18, PENNSYLVANIA

"Cross country or cross town, our Buckeyes deliver more ditch"

– says Raymond F. Pitman, President, Universal Pipeline Constructors, Inc.

"We chose six Buckeye ditchers to dig the 1,200,000 feet of ditch called for in our contract with Intermountain Gas Company," reports Mr. Pitman, "and whether it's been rugged cross-country work or narrow-alley city ditching, these machines have been more than a match for any conditions we've met!

"Because wheel hoist and conveyor drive are hydraulic and work independently of each other, we can dig a straight-line ditch exactly where we want it . . . place spoil on either side and at any distance from the machine . . . work over and around existing pipes and lines without stopping forward travel. And, all adjustments are made right from the operator's seat.

"In the 70,000 feet we've already dug, these Buckeye ditchers have really proved themselves. The 308's have kept production high on overland segments. Our 305's have given us the accurate control needed for close-quartered city jobs and have turned in dependable performance on in-between-sized jobs!"

Find out for yourself how much more profitable ditching can be with an advanced Gar Wood-Buckeye machine. Call your Gar Wood-Buckeye dealer, or write direct to: Customer Service Dept., Gar Wood Industries, Inc., Wayne, Mich.

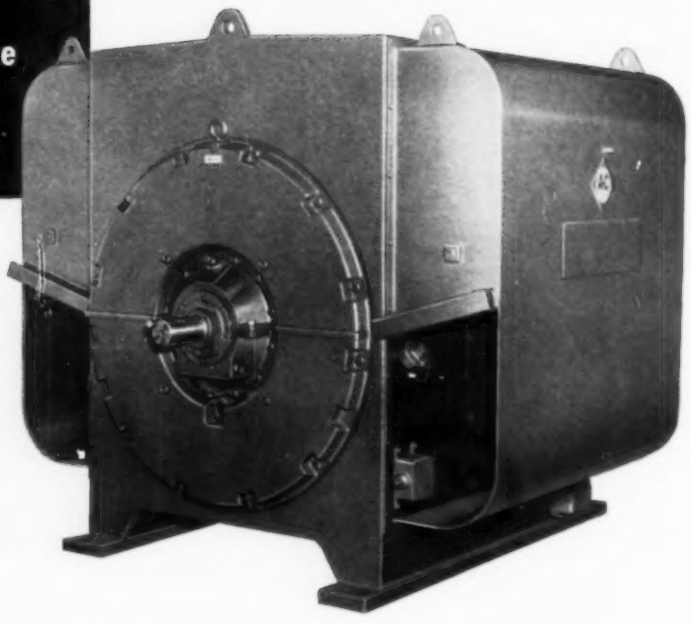
Gar Wood Buckeye

GAR WOOD INDUSTRIES, INC.

Wayne, Michigan • Findlay, Ohio

Eliminate costly enclosures with Allis-Chalmers weather-protected MOTORS

Modern features cut operating, maintenance expense... give MORE dependability



Here's a newly designed line of Allis-Chalmers weather-protected motors with the ability to "take" outdoor conditions. This means no expensive protective enclosures are needed . . . a big saving in plant or installation building costs.

Designed to meet defined NEMA requirements, these motors incorporate many important features which assure dependable outdoor operation:

- **Ventilating System** — Low velocity intake, vertical lift, change of direction and high velocity discharge of ventilating air keep rain, snow, sleet, dust and dirt out of vital parts.
- **Removable Air Ducts** — To facilitate inspection and maintenance of interior air passages, air intake ducts are designed for quick removal.
- **Stator Assembly** — Removable as a unit, it simplifies maintenance and minimizes downtime.
- **Split Sleeve Bearings** — Capsulized design permits access to motor interior without disturbing the bearings or their enclosures. Positive vapor seal is used on high-speed motors. Antifriction bearings are available for slow speed motors.
- **Proven Insulation** — Famous Allis-Chalmers insulation systems (Class A and B) are available. And, for extreme temperatures, or where high resistance to abrasion and moisture is required, Allis-Chalmers can provide the revolutionary *Silco-Flex* system.

Silco-Flex is an Allis-Chalmers trademark.

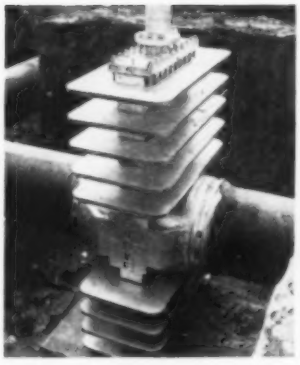
THIS DESIGN available in ratings from 250 to 900 hp. Other designs in larger horsepower ratings are also available. Contact your A-C sales office or write Allis-Chalmers, General Products Division, Milwaukee 1, Wisconsin. Ask for Bulletins 51B8606A and 05B7894.

A-5292

ALLIS-CHALMERS

Perfect through-conduit alignment simplifies hot tapping through this 22" ASA 600 valve.

34" full opening high pressure gas valve will stay bubble-tight underground — with no lubrication or maintenance.

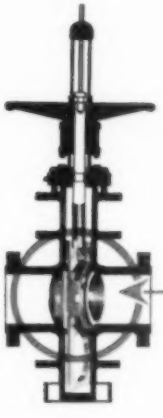


Ease of operation is of prime importance on frequently used manifold installations.

PERFORMANCE in the field points up the BIG DIFFERENCE

— in bubble-tight seal you can check in the line
— in easier operation with no wedging or jamming
— in lower maintenance with no need for lubrication
— in through-conduit always in line with the line

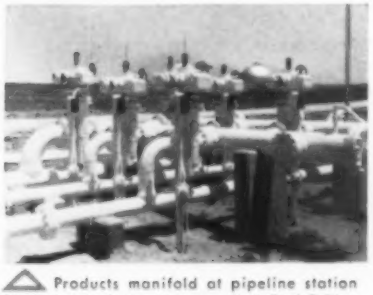
Thousands of pipeline, manifold and storage installations in gas and liquid services are daily adding to the record of performance that makes Grove *Seal-O-Ring* Gate Valves stand out as the practical answer to operating problems. If you have any doubt, ask men who are using them. It will pay you to specify Grove *Seal-O-Ring* Valves with the fabricated steel body—2" to 36"—in any standard pressure. Call your Grove representative or write today for details.



THE WHOLE VALVE IS RIGHT HERE

When valve is full open or closed, bubble-tight seals on both sides of the gate completely isolate line pressure in the conduit. The body, serving merely as framework for operating mechanism and to prevent loss of product while gate is in motion, may be drained or vented to atmosphere when gate is open or closed. Integrity of seals can be checked any time by a tell-tale valve on the body.

703



Products manifold at pipeline station illustrates typical motor-operated *Seal-O-Ring* Valve application.

LPG tank-to-pipeline is critical service where it's well to be able to check seal in the line—any time.

Self-cleaning feature is particularly important on crude oil tank lines.

GROVE SEAL-"O"-RING Gate Valves

SUBSIDIARY OF WALWORTH

GROVE VALVE and REGULATOR COMPANY • 6529 Hollis St., Oakland 8, Calif.
HOUSTON 23—3517 Polk Ave. • • • • • **LOS ANGELES 6**—1930 W. Olympic Blvd.

GROVE SEAL O RING GROVE SIMPLICITY ACCURACY SAFETY

ODESSA, TEXAS • TULSA, OKLAHOMA • CHICAGO, ILLINOIS • DENVER, COLORADO • In Western Canada: GROVE VALVE LIMITED, EDMONTON

Snow, winter temperatures, and frozen ground didn't shut down this pipeline job. Digging 16 inches wide, 2 feet deep, Parsons Trenchmobile averaged 5,000 lineal feet of trench every 9-hour shift.

Typical Trenchmobile schedule:

Yesterday **— pipe reclamation**
Today **— production trenching**
Tomorrow **— trouble-shooting**

When it comes to all-around usefulness — in pipeline spreads, or around refineries, terminals, producing plants — Trenchmobile is in a class by itself! It's big enough for digging gathering-lines, laterals, and other production trenching — yet, is small enough, fast, and mobile for economical one-man operation on scattered, small-yardage work. It travels from job to job under its own power, drives over highways, cross-country, through towns at 12.6 m.p.h. There's no waiting for trailer, no loading or unloading delays.

Trenchmobile works fast, too. It opens trench at speeds up to 14.5 feet per minute, depending on width, depth, and soil conditions — digs 8 to 16 inches wide, at depths to 5 feet. Positive down-crowd boom starts cut fast in tough materials, holds accurate grade — makes vertical set-ins on lateral connections, undercuts cross-pipes. Self-sharpening, "Tap-In" teeth assure top digging efficiency at all times. Shiftable, reversible belt conveyor gives controlled discharge. Trenchmobile also can be equipped with 6-foot blade (optional) — backfills its own trench. There's no limit to its usefulness as a general-utility trencher, or as an auxiliary production unit. Ask Parsons distributor to demonstrate what it will do for you. Call him today — or mail coupon for latest Trenchmobile catalog. Also check Parsons complete line of heavy-duty Trenchliners® — wheel and ladder-types.

PARSONS COMPANY, Newton, Iowa *(Division of Koehring)*

Send us: ☐ spec. sheet ☐ catalog on Model 88 Trenchmobile.

NAME_____

TITLE_____

COMPANY_____

DIVISION_____

STREET_____

CITY, STATE_____

P562 PE

CHECK PARSONS FOR TRENCH WIDTHS FROM 8 TO 72 INCHES . . . DEPTHS TO 17 FEET

16 to 26 inches wide

WITH PARSONS 150

There is no need to dig and backfill excess yardages on feeder lines, laterals, gathering systems, etc. This medium-size wheel-type Trenchliner fills the bill on secondary lines — and has ample work range to handle a good share of your main-line trenching, too. You get cutting widths from 16 to 26 inches, depths to 5¾ feet with the Parsons 150. What's more, 30 digging speeds from 12 inches to 25 lineal feet per minute assure maximum production at every depth, width, in all soils.

You'll also like its precision grading accuracy. A hydraulic ram on vertical mast raises and lowers the digging wheel — gives infinite depth selections, maintains close grade tolerance even in toughest digging. A separate hydraulic ram tilts the mast, balances weight of wheel forward on the 150 Trenchliner when traveling or trailer-loading.

Heavy-duty wheel takes cast-steel buckets with self-sharpening, reversible "Tap-In" teeth, or quick-change gumbo buckets. Shiftable, reversible belt conveyor discharges spoil to either side. 16-inch crawlers, grouser-type shoes, provide plenty of digging traction with low bearing pressure for cross-country work. Let your Parsons distributor tell you more about it, or write for 150 Trenchliner catalog.

PARSONS COMPANY • Newton, Iowa

A division of Koehring Company

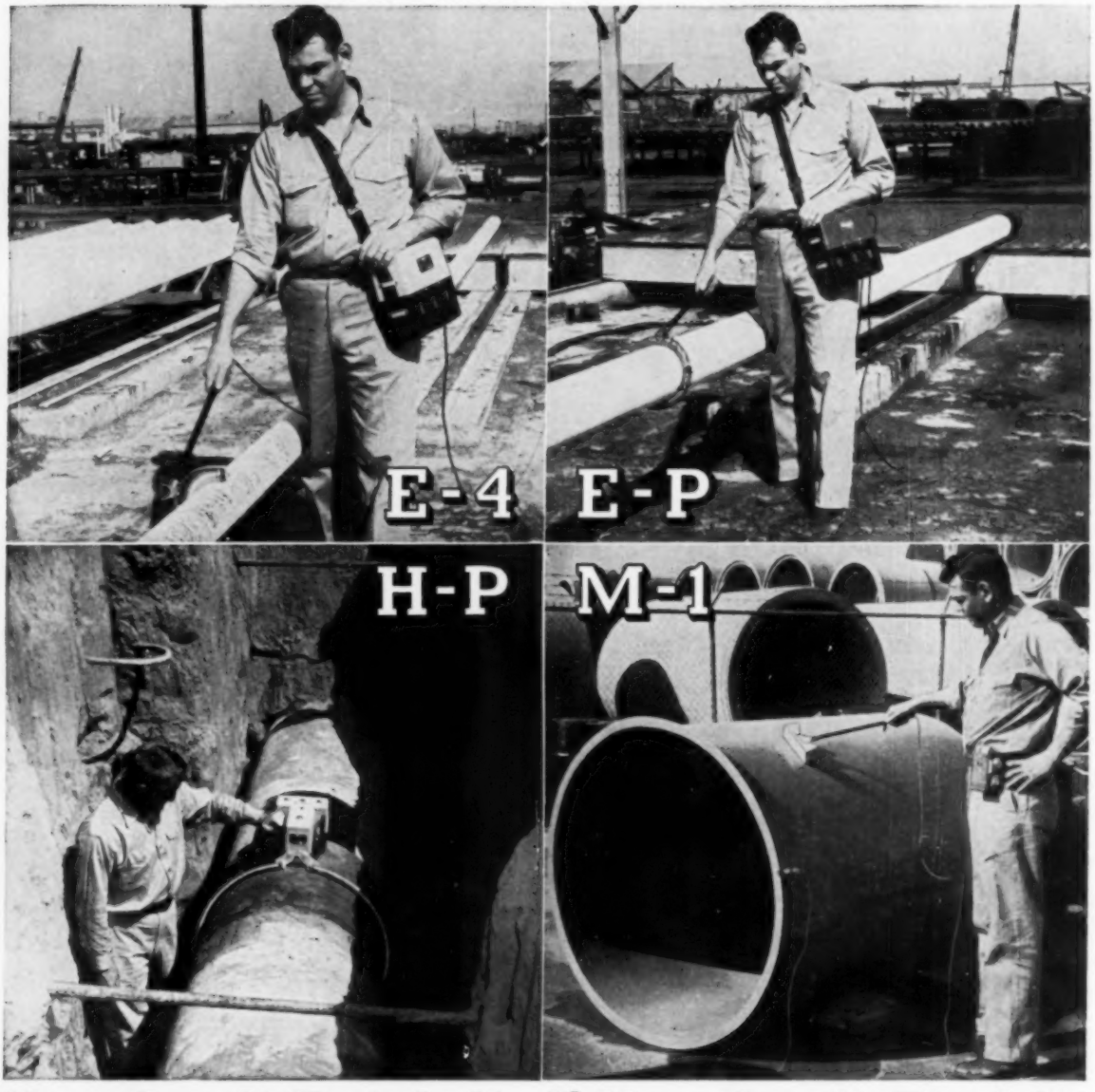
31 to 46 in. wide

with MIDDLE-INCH 420

For the big transmission lines, here's a Middle-Inch 420 Trenchliner, with cutting widths of 31 to 46 inches, depths to 7½ feet. Need still more capacity? Then check the Parsons Big-Inch 520, which digs 40 to 52 inches wide, 8½ feet deep. Both "Inchers" are wheel-type ditchers, formerly built by C-R-C. Parsons line also includes ladder-type Trenchliners — all sizes, from a small utility model on rubber tires to big, crawler-mounted models that dig up to 6 feet wide, 19 feet deep.

P736

TRENCHLINERS® for PIPELINERS



You Can't Patch It - If You Can't Find It!

These Electrical Detectors Show Up Weak Spots in Protective Coatings

E-4 Portable, pack-type, all-purpose, holiday detector with wet-cell battery output adjustable from 2500 to 20,000 volts D.C. Inspection electrodes for pipe sizes ¾ to 30-in. diam. also steel brush for surface checking. E-4 checks dry surfaces only.

E-P Holiday detector similar to E-4 but suitable for testing either wet or dry surfaces. The best general-purpose holiday detector made. Comes in sturdy carrying case with battery charger.

H-P Pipeline "Jeep" for field testing wrappings and field joints on transmission pipelines 4 to 36-inch diameter. Fully portable. Has own power supply. No generator needed. Creates a working voltage 12,000 to 15,000-v. Not hot spark. No trailing ground wire. Virtually shockproof. Snap-off electrode.

M-1 Belt-mounted inspection instrument weighing but 3 lbs. Wand holds cellulose sponge which is dampened with plain water. When wiped over any painted or coated surface up to 10 mils thick it will signal pinholes or breaks by bell signal.

BEAT NATURE TO THE PUNCH

Your protective coatings on metal or concrete are only as good as their weakest points. Nature will seek out pin-holes and thin spots caused by air bubbles, dirt, coke or rust in the protective coating. Be safe and check pipe or other painted surfaces before putting them into severe service. A Tinker & Rasor electrical detector can quickly find the weak spot in your coating—wet or dry. It can do so rapidly and efficiently and without physical damage to the coating in any way. There is a T & R Holiday Detector for every surface testing job + each is fully guaranteed.

Write for data, costs, specifications. Inquiries receive prompt attention.

TINKER & RASOR

417 Agostino Rd. (P. O. Box 281) Phone: ATlantic 7-7942, SAN GABRIEL, CALIFORNIA

BOB HERRICK, Rentals & Service, Harrisburg, Pa. • Phone CEdar 6-5263

DISTRIBUTORS: Ronco Mfg. Co., Inc., Tulsa, Oklahoma; Crutcher-Rolfs Cummings, Houston, Texas; Lino Products, Elizabeth, New Jersey; Canadian Equipment Sales & Service, Edmonton, Alberta

Construction men fought terrain and bitter cold in the construction of PNW's "scenic-inch" pipeline.

Why communications have to be good on Pacific Northwest's "scenic-inch" line

Pumping gas over mountain passes across 1487 miles of America's toughest terrain requires the most reliable communications available.

Pacific Northwest Pipeline Corp. presented this requirement to the Bell System, with one additional request—economy.

The result is a private line telephone system that PNW's Salt Lake City control center uses to keep a running summary of conditions along the line. Information gathered in Salt Lake City from each compressor station includes dew point, BTU content and specific gravity of the gas. Dispatchers use this data as guidance in controlling flow.

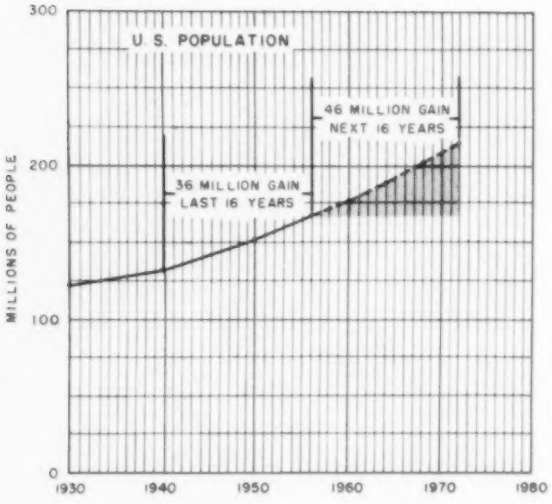
• • •

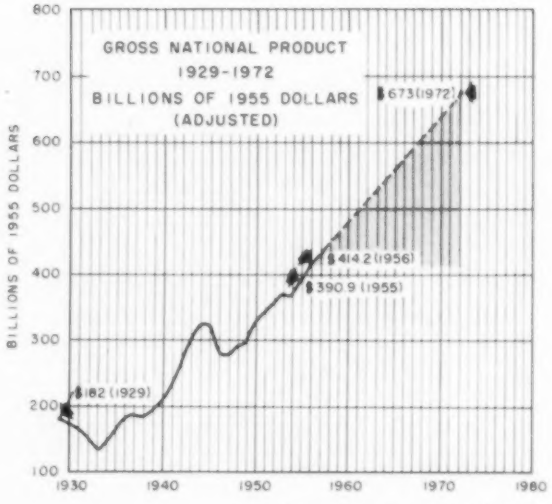
Bell System communications can work for you as fast and reliably. Just call your Bell Telephone Company business office. A representative will gladly discuss your requirements.

Pacific Northwest's Salt Lake City dispatchers collect data hourly from every compressor station and maintenance point on the company's 1487-mile pipeline.

BELL TELEPHONE SYSTEM

PRIVATE LINE TELEPHONE • PRIVATE LINE TELETYPEWRITER DATA TRANSMISSION SYSTEMS • CHANNELS FOR REMOTE METERING AND CONTROL • TELEPHOTOGRAPH • CLOSED CIRCUIT TV





This curve prepared by Ebasco Services, Inc., for the Suez Canal Company, January, 1957.

If you think pipeline construction is nearing the end of

Why Pipelines Will

Donald M. Taylor
Gulf Coast Editor

THERE are 2½ billion people on the earth today — more than 2 billion of them are hungry. Yet, our population continues to grow, and scientists have predicted that it will be 4 billion by the end of this century and 7 billion by 2050.

Can the earth support such vast numbers? The answer is yes — despite the fact that it fails to support four-fifths of its population today—provided the planet's abundant supply of energy is utilized to best advantage.

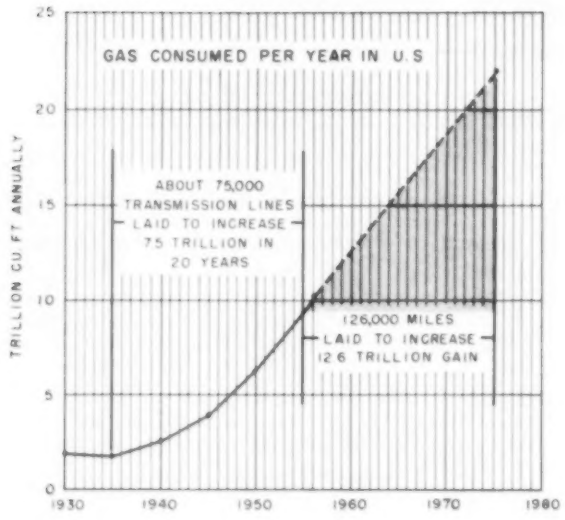
For everything the earth gives us it exacts its price in energy. It takes energy for us to breathe and for us to extract oxygen from the air. It takes energy to eat, to grow crops, and to manufacture steel.

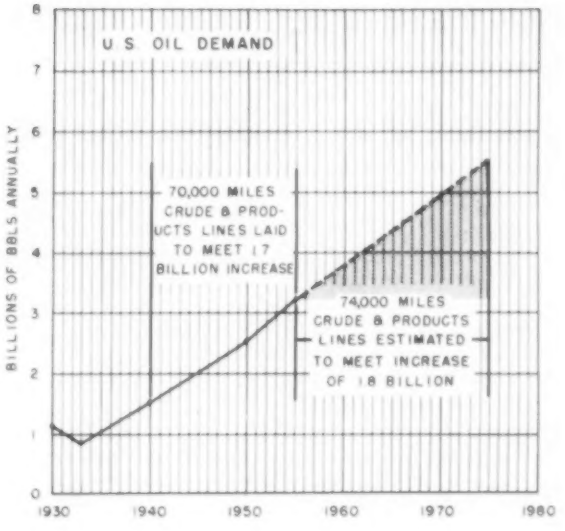
If we expend sufficient energy the earth will reward us with lavish gifts that stagger the imagination. For instance, take a look at what proper utilization of energy could do for our world today. It could transform the Sahara into a garden by bringing to it water from the rain-swept African tropics. It could make the Polar region inhabitable, and supply us with minerals from the sea in unlimited quantities.

Proper utilization of energy could even transform the vast regions of Russia into a land of plenty. If we don't blast ourselves into oblivion in a grotesque war, historians may one day record Russia's imperialistic efforts as the great joke of our age. For like a hog that deserts the corn bin for a single grain of corn, this misguided country sits atop the untold wealth of vast regions, squandering its creative thinking and efforts on developing a means of grabbing lesser resources that have already been developed by others.

How does this affect pipelines? It simply means there is a vast expansion program ahead, because the population will continue to gobble up more and more energy and pipelines afford the best means of transporting a sizable portion of this energy supply to market. In other words, as the population of the earth is increasing, the per capita demand of energy is increasing, compounding future fuel demands. Our oil, gas, and even coal will be pipelined to its users in ever-increasing quantities.

Take a look at our own country's population curve. The U. S. will gain some 46 million in the next 16 years,





a boom era, you had better take a look at these curves

Continue to Expand

and this alone would justify additional pipelines. This great growth is enough to keep oil companies and wildcatters drilling more and more holes every year, and as new fields are discovered their production must be pipelined to markets.

But even as our population grows, our standard of living is becoming greater. From the accompanying illustrations you will note that the total national income will reach $673 billion in 1972 (based on 1955 dollars).

At the same time our demand for energy is soaring. Where once a single automobile was sufficient for any family, today a good portion have two. Our washing machines, clothes dryers, refrigerators, deep freezers, and the like use energy in ever-increasing amounts.

Take a look at our national production curve and you'll see a reflection of our energy demand, because this curve follows the population curve closely.

If our economy does reach the $673 billion mark by 1972 it means that we must build almost 200,000 miles of new transmission lines — not counting gathering and distribution systems.

Last year we used more than 10 trillion cu ft of gas, and by 1972 we will have increased this yearly consumption by some 12.6 trillion cu ft if predictions are correct. To increase our gas consumption by some 7.5 trillion cu ft per year during the last 16 years required 75,000 miles of main transmission lines. By the same token, it will require 126,000 miles of similar lines to increase our annual consumption 12.6 trillion cu ft by 1972.

To a degree the same will hold true of oil lines. In the past 16 years we increased our consumption by 1.7 billion bbl annually, and during this period we constructed some 70,000 miles of crude and products main lines. If this proportion holds, and we expand our annual consumption by 1.8 billion bbl annually, by 1972 we must have constructed some 74,000 miles of additional lines.

This figure may vary depending on where our great new sources of oil and gas will be located. As matters stand today, geologists are predicting that the offshore Gulf of Mexico, western Canada, and the Rocky Mountain region will be among the leading suppliers of oil and gas in the future. Also, we must transport ever-increasing quantities of fuel to inland refineries and markets as our needs increase.

While this great expansion is taking place in the U. S., even larger expansion may take place abroad. Western Europe is headed toward a vast economy that should almost equal that of the U. S. in the foreseeable future, and to accomplish this feat, oil and gas must become available in greater quantities. As a matter of fact, pipelines probably hold the key to Europe's great stride toward independent economy. A great new oil field was discovered a year ago in the Sahara Desert, and until now has been awaiting a pipeline connection while Europe suffers for oil. Geologists have compared this discovery with that of Venezuela. At the same time Middle East oil has been tied up by the Suez Canal, which has withered and faded under the grasping hand of an incredibly stupid dictator. It must be bypassed with pipelines if Europe is to prosper.

Some day the nations that comprise western Europe and the Middle East may learn the futility of squabbling and discover the advantages that pipelines can bring them. ★ ★ ★

METER FACTOR CONTROL CHARTS

Solve Measurement Problems

Their use tells Trans-Northern operators the exact time and place meters go wrong and what is causing the trouble

L. M. Davis
Measurement Engineer
Trans-Northern Pipe Line Company

METER calibration on pipelines, although largely a numerical operation, has two principal variables, one the mechanical condition of the meter itself, the other the ability and functioning of pipeline personnel performing the calibration.

Trans-Northern Pipe Line uses meters to accept products into the pipeline system for transportation and for delivery of products to the shippers at numerous terminals along its line.

Inconsistency in metering due to improper functioning of personnel or equipment was difficult to pinpoint. To determine exactly where improper metering was occurring presented a problem. Experimentally, it was decided that the use of control charts at each location where metering was being done was worth a trial. So far as we knew, it was not being used on other pipeline systems.

In establishing a system of control charts, we turned to a text by Major L. E. Simon of the Ordnance Department of the U. S. Army called "An Engineers Manual of Statistical Methods" published by John Wiley & Son, New York. Each chapter is embellished and livened with an apt quotation at the beginning. In the preface we are encouraged thus:

> *"There is no useful mathematical weapon which an engineer may not learn to use."*
>
> *Lord Kelvin*

And for Chapter VIII, the message is:

> *"All nature is but art, unknown to thee;*
> *All chance, direction, which thou canst not see."*
> *Alexander Pope: Essay on Man*

We attempted to "see" if chance applied "direction" to meter factors.

The purpose of any control system is not merely to get control, but to get it at a satisfactory level, which in pipeline measurement means to reduce the variability of meter factors to a practical minimum. It would be possible, of course, to have a set of meter factors that was almost constant — but constantly wrong! This can be guarded against by keeping track of the "line balance," i.e. total barrels in minus total barrels out.

First step in setting up meter factor control charts is the selection of (a) control limits, and (b) standard values for the appropriate statistical measures.

If subsequently it becomes practicable to improve or narrow a standard valve, this can and should be done. In our case it was accomplished about six months after first installing the system.

Statistical measures appropriate to a meter factor control chart are:

(1) $\overline{X}$ is the average of at least 25 individual meter factor determinations on any one meter in any one product, within the range of flow rates and temperatures that are necessary to the successful operation of the pipeline. There may arise situations where less than 25 determinations of meter factor will have to suffice to establish a value for $\overline{X}$, as might be the case with, say, rubber solvent, a comparatively little handled product. In such a case a provisional value will have to be determined with the data available.

(2) σ (sigma) the standard deviation or root-mean-square.

The formula for computing this useful statistical measure is shown in box at bottom of page (Formula A) or expressed in another sometimes convenient form, (Formula B).

Where:

$\overline{X}$ is the average value of all the meter factors in the group being considered.

$X_1\ X_2 \ldots X_n$ represent the several meter factor values in the group

And:

n is the number of determinations, which should be at least 25; if it can be 100 so much the better.

Selection of control limits (the other part of the first step in setting up a control chart) that Trans-Northern's experience appears to vindicate can best be based upon the time honored "3-sigma" formula.

Control limits are action limits for indicating when to look for assignable causes of variation. If the limits are too narrow, much time can be wasted looking for trouble that does not exist; if they are not narrow enough it is possible to overlook trouble that does exist.

The 3-sigma formula in the general application of control charts to industry is said to strike an economic balance between the above two kinds of error.

And so, our "Calibration Reports" for each meter were assembled and sorted into piles for the several products: Fuel oil, stove oil, kerosine, solvent, jet fuel, motor gasoline, etc.

Average factor ($\overline{X}$) was determined for each product in each meter and the individual deviations from average were then listed and the standard deviation (σ) determined in the prescribed way, all of which can be presented best by means of an example.

How a Control Chart Is Set Up

Fig. 1 shows an early meter factor control chart. Horizontally along the abscissa are plotted the values of successive meter factors. The ordinate scale is marked off in increments of 0.0020 (20 "points") between the

Formula A:

$$\sigma = \sqrt{\frac{(X_1 - \overline{X})^2 + (X_2 - \overline{X})^2 \ldots + (X_n - \overline{X})^2}{n}}$$

Formula B:

$$\sigma = \sqrt{\frac{X_1^2 + X_2^2 \ldots + X_n^2 - \overline{X}^2}{n}}$$

heavy lines. Scaling of the ordinate is determined by behavior of a typical meter, that is to say, by the value of the standard deviation. For practical purposes a convenient value is assigned to σ after a preliminary analysis.

Let successive meter factors determined on any one product (say Motor Gasoline in Gravity Group 3) on any one meter be X_1, X_2, $X_3 \ldots X_n$. Let the average of at least 25 such values be $\overline{X}$ and equal to say 1.0031.

Make a tabulation with three columns, listing first, each succeeding meter factor value (X_1, X_2, etc.); second, its individual deviation or difference from the average $(X - \overline{X})$, and third, the square of this difference $(X - \overline{X})^2$ thus:

X	$(X - \overline{X}) \times 10^4$	$(X - \overline{X})^2 \times 10^8$
1.0026	5	25
1.0049	18	324
1.0029	−2	4
1.0021	−10	100
1.0033	2	4
1.0031	0	0
etc.	etc.	etc.

Note that it is a lot less cumbersome to call the difference between 1.0036 and 1.0031, 5×10^{-4}, and its square 25×10^{-8}, than to write 0.0005 and 0.00000025, especially when it comes to taking the square root of the sum of these squares divided by the number of factors (n), which is how the observed standard deviation (σ) is defined.

Add all the values in the third or right-hand column, divide by the number of factors (n), and take the square root. Result (σ) gives a good idea of just how this particular meter is performing.

About two years ago we found that typical standard deviations ran from 0.0017 to 0.0038 with a value of perhaps 0.0025 as representative. Control charts (Fig. 1) were then set up (one for each product on each meter) and installed at each meter station, selecting the value 0.0020 as the assigned value of σ.

It took but a short time to show the operators how to use the charts, and to see their attitude change from slight suspicion (for, after all, the charts show the performance of the operator as well as the meter) to interest and even pride in how well they can "smack those factors right down the middle of the chart."

Charts are posted immediately after calibrating a meter, so that if the results are "out of control" something can be done about it without delay.

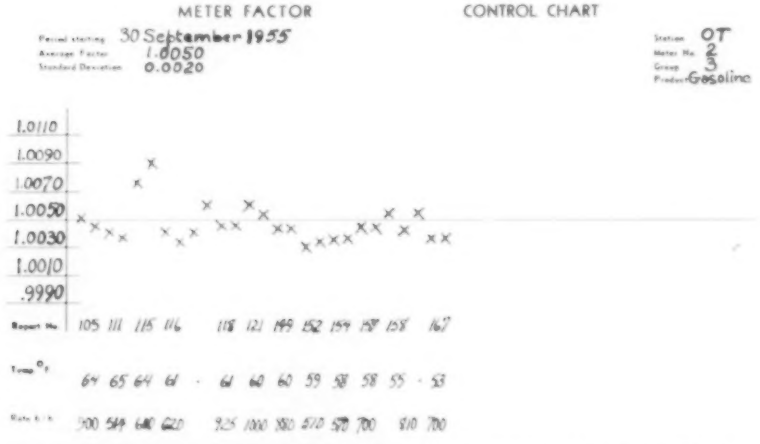


FIG. 1. One of the early control charts in which the assigned value for a standard deviation is 0.0020. Center line of the chart is drawn in red and is colloquially referred to as the "red line value" of the meter in question. Red line value is the average factor (X) over an extended period.

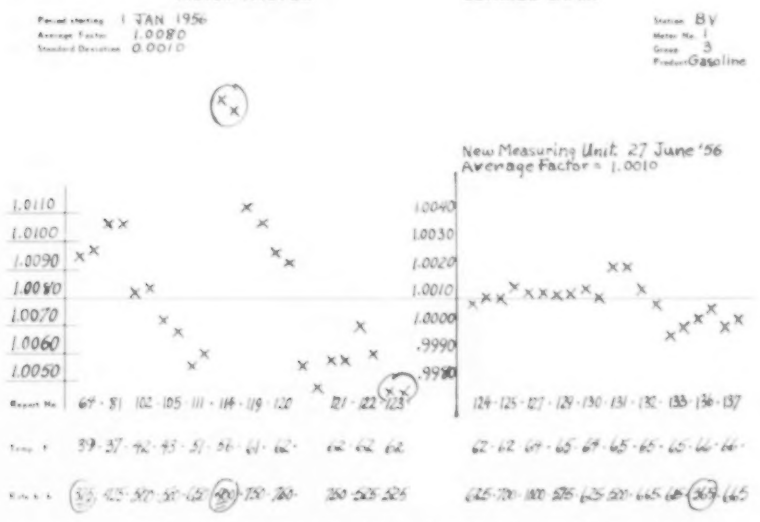


FIG. 2. A 1956 control chart is which the standard deviation had been reduced to 0.0010, so that fluctuations are twice as exaggerated as before. Left half of the chart shows typical behavior of a meter that has something wrong with it — an "assignable cause" as yet unknown. Because of the wild oscillations between too high and too low, the meter was taken apart and showed a badly scored bearing, wear, and considerable dirt. A new measuring unit was installed June 27, 1956 and behaved handsomely — in the same product with the same operators — as can be seen in the right half of the chart.

Results from Use of Charts

Our control charts had the same sort of results as has often been claimed for them in the manufacturing industries, that is, some expected and others unexpected, but all good.

First, the previous variability of meter factor values was steadily narrowed by the simple process of letting those concerned "see" the direction chance was taking instead of working in the dark in which "All chance, (is) direction, which thou canst not see."

Second, when one or more meter factors went "out of control," (that is off the $\pm 3\ \sigma$ lines of the control chart) an assignable cause could be looked for and invariably was found quickly.

Third, when the assignable cause required the attention of the meter mechanic he could be summoned immediately instead of waiting for him to catch the trouble on his regular rounds (Fig. 2).

Fourth, the meter mechanic could (and now does) arrange his maintenance work largely from an examination of the control charts rather than on a time or barrel basis. A meter could need attention every few weeks if conditions were unfavorable (such as scraper dirt getting in) or might go for 5,000,000 bbl or two years without the need of any attention at all if conditions were favorable.

Fifth, we learned that even a trace of scraper dirt will throw the meter factors off — in an upward direction

— for several thousand barrels before it is finally flushed through, and that sometimes it won't flush through but must be removed (Fig. 3).

As a result, we now remove the rotors before scrapers are expected, and measure by tank gage instead. We also found that enough scraper dirt can get into the dead ends and quiet corners of a meter station manifold to "gum up" (quite literally) the rotors during the second or even third calibration after the arrival of the scrapers, which could be several days later.

Sixth, the interest of operators in exact metering is aroused and sustained. They can take an active and seeing part instead of a passive and blind one. It might be the place here to answer in advance a question that could arise in the reader's mind:

"With all the calibration results plotted on a chart and available for comparison, isn't there an inducement for the operators to 'cook' the results? Don't you encourage 'pencil calibration?' "

We can only say that it hasn't worked out that way. After all a control chart highlights a man's ability and makes it more worthwhile to be skillful than is the case when a meter factor is just a number more or less buried away in the dark. Calibration can become a sort of target practice to liven up an uneventful shift!

Seventh, after about six months use of control charts the consistency of our meter factors improved so much that the standard deviation (σ) was no longer 0.0020 or more, but 0.0010 or less. One year ago a new set of charts was set up with 0.0010 as the assigned value of (σ) instead of 0.0020 as therefore. The change appears to exaggerate factor variation twice as much as was the case before.

Accuracy of Measurement

The more closely the plotted values of meter factors fall around the center line of a control chart, the more consistent and more accurate can measurement be expected to be. The expectation of accuracy can be expressed precisely by working out the standard deviation of a particular meter and comparing it with another, or with the same meter for another period of time.

By bearing down on meter factor consistency, largely by finding the assignable cause of "wild factors" and doing something about them, Trans-

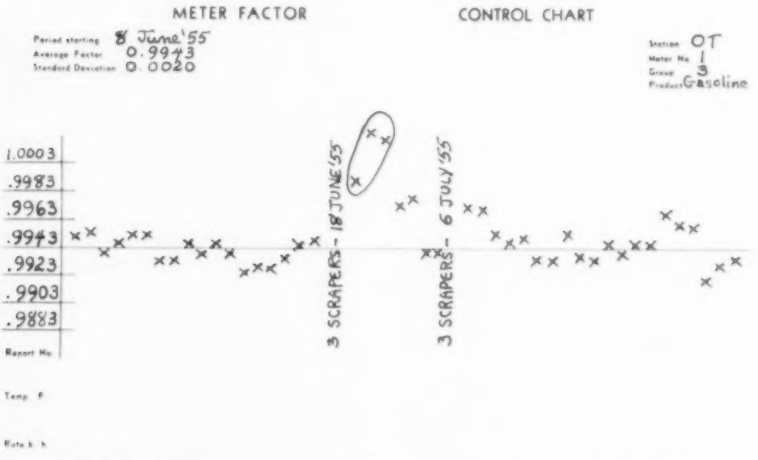


FIG. 3. Typical reaction to scraper dirt. The two sets of scrapers arrived with but a short interval between, so that with less dirt in the line to stir up there was, as might be expected, less reaction to the second set than the first. All meters at end-of-the-line stations responded the same way to scraper dirt, which caused Trans-Northern subsequently to take out the measuring units and measure by tank gage on such occasions. This was in 1955 when the standard deviation was still set at 0.0020.

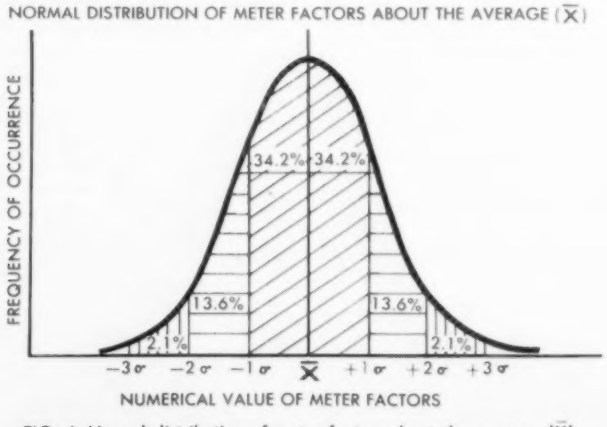


FIG. 4. Normal distribution of meter factors about the average ($\bar{X}$).

The Author

L. M. Davis is measurement engineer for Trans-Northern Pipe Line Company, Toronto, Canada. He was graduated from University of Alberta 1934 with a bachelor of science degree, and entered the chemical industry. During the war he was works manager of a Shell loading plant in Montreal in which control charts formed the basis of quality control. After the war he entered the petroleum industry as process engineer with British American Oil Company in 1945. Subsequently spent six years in various phases of industrial relations, and then returned to technical work with Trans-Northern Pipe Line when it was under construction in 1952. Davis is a member of Chemical Institute of Canada, and American Society of Safety Engineers.

Northern has experienced a gradual improvement of standard deviation from typically 0.0025 to 0.0010 or less.

Of course, not all meters show a gradual improvement. Some show the opposite, but this in itself can be turned to account by overhauling or changing the measuring unit. Dirt and wear are the usual causes of a worsening deviation.

Variability of meter factors to some extent is pure chance, and if individual values are plotted in the form of the well-known probability curve (Fig. 4), and the standard deviation is determined, it is possible to predict what proportion of batches or tenders will be measured to known degrees of accuracy.

All (100%) of those "under control" will be accurate to ±4 standard deviations

99.7% of those "under control" will be accurate to ±3 standard deviations

99.5% of those "under control" will be accurate to ±2 standard deviation

68.3% of those "under control" will be accurate to ± 1 standard deviation

If, for example, the standard deviation on a certain meter worked out to 0.0025 (0.25 percent) then substanti-

ally all (99.7 percent) batches measured through it would be measured with an accuracy of ± 0.75 percent (i.e. 3_{σ}). If the standard deviation were improved to 0.0010 or 0.0007 the same fraction (99.7 percent) of the batches would (with random distribution) be measured with predictable accuracies of ± 0.30 percent and ± 0.21 percent, respectively.

The larger the quantities measured, such as weekly, monthly, or yearly throughputs, the more will inaccuracies in individual batch measurements tend to cancel each other out. Trans-Northern's monthly balances run within ± 0.03 percent and for the second half of 1956, when slightly more than 10,000,000 bbl of product were transported, the balance worked out to less than 0.01 percent — 1 percent of 1 percent.

Needless to say control charts cannot solve all problems of measurement, but by bringing into the light "assignable causes" of inaccuracy as quickly as they arise, they make it possible to get after them early.

Some of the causes of factor variation could of course be expected, such as changes in rate beyond customary limits, or changes in viscosity due to changes in temperature.

Other causes were more or less expected but hard to pinpoint without a control chart, such as gradual wear allowing greater slippage of the less viscous products and therefore a gradual increase in the factors. Or, the habit some operators developed while calibrating of closing the plug cock leading to the prover tank too slowly, thereby pinching the rate down instead of shutting it off smartly.

Some other causes were quite unexpected, such as the excessively harmful effect of dirt; a broken filter basket letting through accumulated dirt; the need for a "wet run" before each calibration, in order not only to condition the tank, but to apply tension in the same direction to the numerous gears of the meter (Fig. 6).

Trans-Northern's experience with control charts lead us to conclude that if the wild factors and the freaks can be gradually done away with, the standard deviation of a meter will improve automatically. But it is important to take the freaks into account when calculating a standard deviation, first because if you don't it is like cheating at solitaire (you are only fooling yourself) and second because the occasional wild factor would seem to indicate trouble ahead.

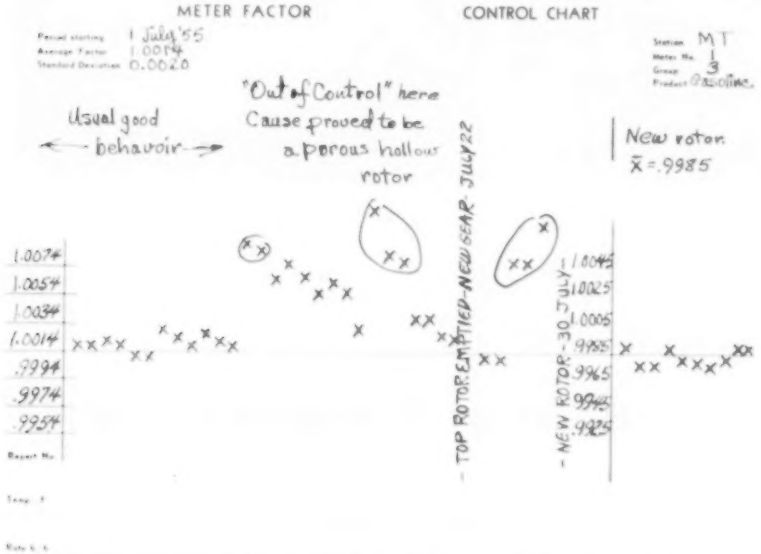


FIG. 5. This meter had been behaving well for a year. Suddenly it went "out of control," i.e. off the chart. Cause proved to be a hollow and permeable rotor. One quart of product was emptied out and the unit put back on line. It behaved for a short time and then went "wild" again. A new rotor was installed and it promptly settled down for another year — about 4,000,000 bbl. As in Fig. 3, the details of Line Temperature, Rate, and Report No. are left out.

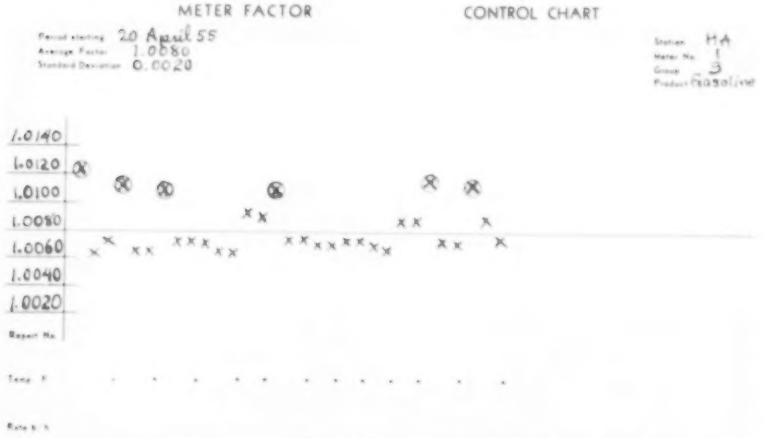


FIG. 6. Chart whereon a number of values (ringed) are all high. Investigation brought to light the fact that each high value was the first of the series of determinations made to establish a meter factor, and that in every case another meter at the station had just been calibrated so that the operator thought it was not necessary to make a "wet run" again. It was the habit to "flip" the numbers on the meter to zero before calibrating, and it was not appreciated at the time that in doing so the tension of all the gears between the rotors and the recording head of the meter was released, so that a few turns of the rotors was required before registration recommenced. Such a condition, of course, always gave a high factor. It is now standard practice to make a wet run before all calibrations and never to flip the numbers between determinations.

Control Charts Easy to Read

One of the virtues of control charts is the ease of reading them. The eye can fairly well catch the average value ($\bar{X}$), and it seems that more can be detected at a glance than can be subsequently rationalized.

No doubt there is a danger of seeing "patterns" in nothing more than statistical fluctuations, but after a while it does seem that you can discern some cause at work that is making a meter act unusual. For example, we had one case, a meter with a hollow cast-iron rotor that proved to be permeable to product. The control chart (Fig. 5) indicated something was wrong long before the fact was confirmed by taking the meter apart. After the hollow rotor was drained, fixed, and re-installed it ran well for a while and then again the control chart foretold that the meter's days were numbered. The measuring unit had to be replaced.

To sum up, meter factor control charts tell when measurement goes wrong and the exact place and time; they are easy to understand and use; they make exact comparison possible; they arouse interest. ★ ★ ★

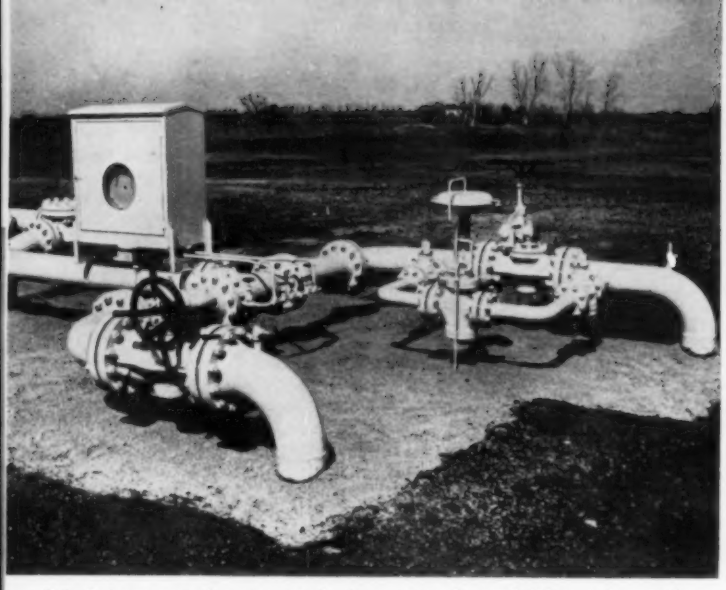


FIG. 1. Loop control equipment showing motor valve and differential controller.

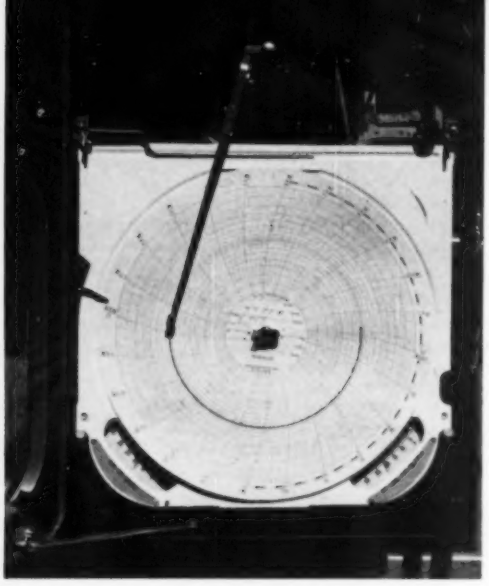


FIG. 2. Differential controller chart with pen on zero.

P 615.24.

Partial Loops to Increase Pipeline Capacity

When greater load is needed, but is insufficient to justify a complete second line, partial loops, with extensions later, have been the answer for Phillips

G. P. Jennings

Superintendent of Operations
Products Pipe Line Division
Phillips Pipe Line Company

THE customary method of increasing capacity of an existing pipeline is to install additional power. Power may be installed at existing stations, thus increasing the discharge pressure or new intermediate stations may be built.

Eventually, the maximum allowable discharge pressure will limit the power that can be used in an existing station, and economics may prohibit the operation of additional intermediate stations.

One obvious solution, of course, is to lay another line; however, the forecasted load for the immediate future may not justify the large expenditure necessary for a complete second line. The solution, therefore, is to install partial loops to handle the load forecasted for the immediate future and later extend or complete the loops when necessary.

When using partial loops, the flow in each pipe must be controlled so that the interfaces between two products will arrive at the end of the looped sec-

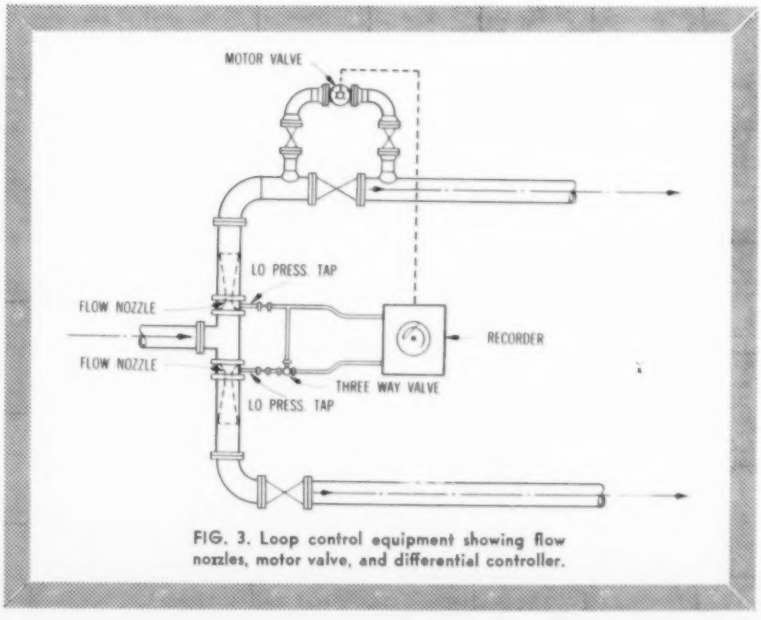


FIG. 3. Loop control equipment showing flow nozzles, motor valve, and differential controller.

tion at the same time. A sample and quite accurate method of control is by using flow nozzles as shown in Fig. 3. If each leg of the loop is constructed with pipe having the same inside diameter, the flow nozzles should be identical.

In a flow nozzle the pressure drop from the inlet to the throat is a measurement of the flow. With the arrangement shown in Fig. 3, the two nozzles have exactly the same inlet pressure; and, if one maintains the same throat pressure in each nozzle, the pressure drops, therefore, will be equal, and the two flow rates also will be equal.

When a new partial loop is laid, the new pipe usually will be smoother and tend toward freer flow. This side of the loop, therefore, must be pinched. A motor valve of a smaller size can be installed in a bypass as shown. The motor valve is operated by a differential controller. One side of the differential controller is connected to the throat of one nozzle and the other side to the throat of the other nozzle.

A 20-in. range differential controller is used. Zero is at the half-way point on the chart, which records 10 in. of water each way from zero. The large bypass valve is set by hand to pinch the major part of the flow. The motor valve accomplishes the fine control, keeping the pen on zero, which indicates that the throat pressures are equal.

If the two sides of the loop are composed of pipe not of the same size, as is the case in Fig. 4 and 5, the throat areas of the two flow nozzles must be proportional to the areas of the two lines, or line fills, of the looped section.

Fig. 4 shows the hydraulics of looping an 8-in. line with another of substantially the same size, whereas Fig. 5 shows the hydraulics of looping with a larger size pipe. It will be noted that the amount of pinching required is not large even when looping with a pipe of a larger size.

It also can be noted that partial looping in effect, places the stations closer together. This permits a greater pressure drop per mile in the single line section, and therefore greater pipeline capacity is obtained.

The Author

G. P. Jennings is presently superintendent of operations of the Phillips Pipe Line Company products pipeline system. For the past 19 years, he has been actively engaged in pipeline operations; and before that he spent eight years in the General Engineering Department on design and construction of pipeline facilities. He served in the zinc industry as design engineer and was also a service engineer on locomotive feed-water pump and feed-water heater problems. Jennings obtained his ME degree from Rensselaer Polytechnic Institute.

Phillips Pipe Line Company has used this method of controlling partial loops for many years on its products system, under U. S. patent 2,361,478, October 31, 1944. At the present time, 19 partial loops totaling 257 miles (514 pipe miles) are in operation on an 8-in. line pumping about 40,000 bbl per day.

Loops are checked about every two years by inserting a shot of dye at the start of the loop and observing the difference in arrival time at the end of the loop. If the arrival times are in error by more than 2 sec per mile of loop, the differential controller is set off zero to correct, and another dye check is made. The 2 sec per mile totals 514 sec, or 8 min and 34 sec, for the entire 19 partial loops.

At a pumping rate of 40,000 bbl per day, or 27.8 bbl per min, the total mixing would be 238 bbl. Total line fill that is displaced in the 19 looped sections amounts to 176,000 bbl. The 238 bbl of mixture therefore amounts to 13 percent of the product pumped while the interface is passing.

This accurate control probably can be explained by realizing that the flow nozzle measurement errors of one nozzle are canceled in the other nozzle, as each nozzle is handling the same product under the same conditions at all times. The flow nozzle throat is made quite small, which also contributes to accurate control. A pressure drop of 10 to 12 psi from the inlet to the throat will give accurate control. A flow nozzle with a recovery cone will recover 70 to 80 percent of this pressure drop.

Although the operation of the loop control equipment is observed frequently by station personnel, it requires little repair. When the automatic control fails, the operator can pinch by hand occasionally until adjustments or repairs are made. ★ ★ ★

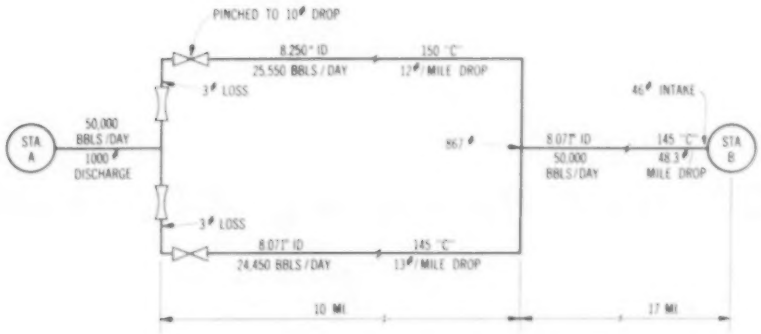


FIG. 4. Hydraulics of looping with pipe of substantially the same size.

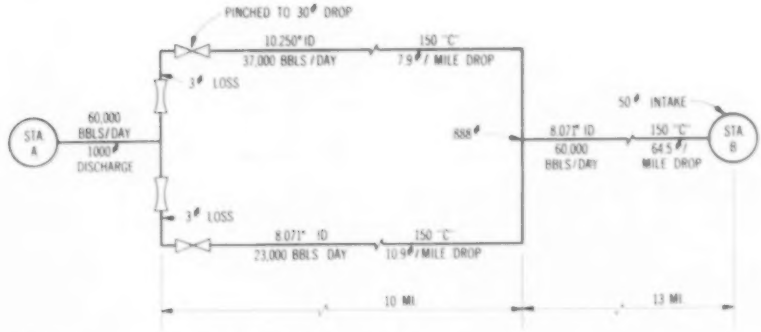
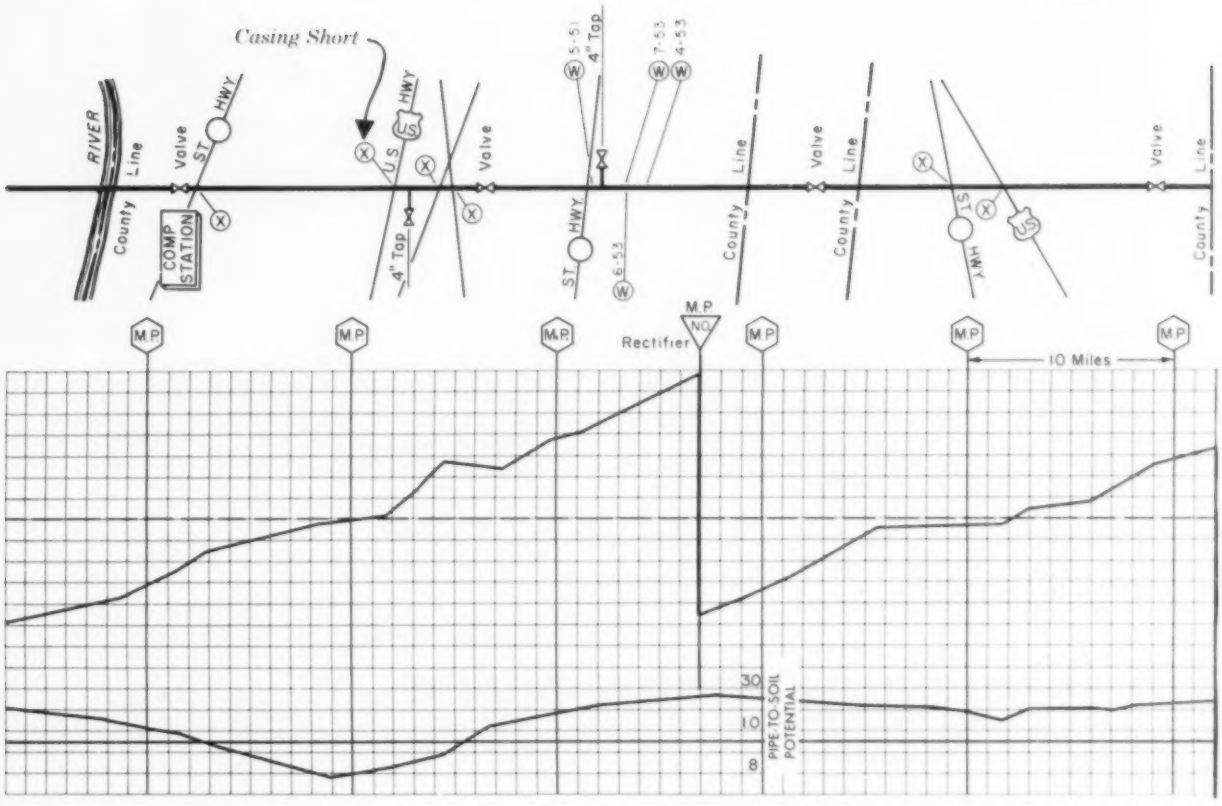


FIG. 5. Hydraulics of looping with a larger size pipe.



Like a billboard, it lists all work to be done and provides a place to check off jobs as they are finished

This Chart Saves Money

Donald M. Taylor
Gulf Coast Editor

YOU can post a schematic chart, similar to the one shown here, in all pipeline division, district, and headquarter offices and go a long way toward aiding pipeliners in "teaming up" on problems.

Although the mere posting of a chart to solve company problems may sound a bit elementary, it has been proven that such a simple addition to the office bulletin board *can expedite work because it spotlights field problems.*

In the dark ages of personnel relations, many companies operated on the blackout principle. Where employees were concerned the attitude was "Tell 'em nothing and keep 'em guessing." This adage, based on the old fashioned system of maintaining military discipline, was used to enforce blind obedience. But, unlike the military services, it didn't work well in industry.

Industrial psychologists and supervisory personnel have long since proved that the employees who know the aims of their departments are the employees who turn out better work. They are happier to boot! *After all, the traveler who sees the road and knows his destination has a happier, safer journey.*

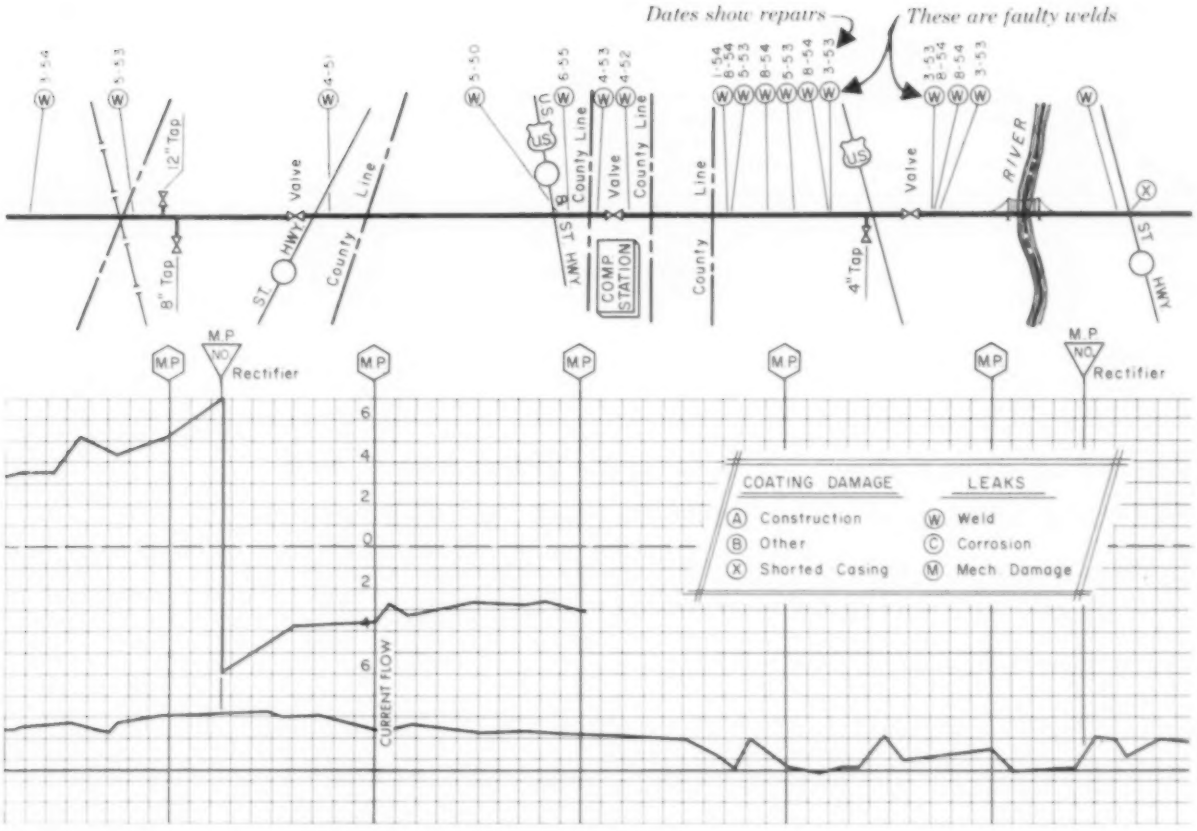
Today most companies have abandoned the blackout method within departments. Most supervisors make a consistent effort to give the men under them a clear picture of the work ahead. This attitude has worked wonders in motivating employees within a department.

Blackouts Between Departments In the Field

But there's still something of a blackout *between* departments, and it is especially common in the pipeline industry. Often men in the pipeline department in the field are unaware of the problems of the compressor department. Generally, there's a gap between the corrosion field engineers and the men who maintain the pipeline — yet essentially they are working on the same problem.

Effects of this blackout can be worsened by the natural rivalry of field personnel. Men working far from headquarters seldom get sufficient recognition for good teamwork, consequently they place great emphasis on individual performance. They are apt to "keep their noses clean" so far as other departments are concerned. **When they do work with other departments, they may communicate via the home office through a linkage of red tape.**

For example, take the usual set up between the corrosion field engineer and the pipeline department. The engineer makes his surveys working alone or independent of the pipeliners. Along with more important duties, he is saddled with the task of driving miles to take readings at test leads, although pipeliners may be working in the same vicinity. Finding evidence of shorted casings or other difficulties, he reports to the home office. After a lapse of



On Pipeline Maintenance

wasted time, the information hurdles the interdepartmental walls and comes back to the pipeline maintenance forces. Thus, in reality the engineer and the maintenance men are working separately on the same problem and communicating through a network of red tape!

Why shouldn't they cut the red tape and work together? There are many advantages. Pipeliners could perform routine work for the corrosion engineer, freeing his time for more technical problems. During a normal workday, the crew can easily pick up readings at test leads with little extra trouble. Moreover, the very fact that crew members work on corrosion problems themselves makes them more conscious of the importance of good coating care, etc.

How the New System Works

Transcontinental Gas Pipe Line Company has effectively cut the red tape between field corrosion engineers and the pipeline maintenance groups. The idea that did the trick is as old as the first billboard sign. It is a schematic drawing of the pipeline system, hung in all division and district offices, showing main line valves, compressor stations, river crossings, mile posts, etc.

On the chart the corrosion engineer posts his pipe-to-soil potential curves and current flows. Pipeliners post such things as leaks, washouts, etc.

As shown in the accompanying chart, if a leak is caused by a bad weld it is marked "W"; if it is caused by mechanical damage it is marked "M." Casing shorts are noted with an "X."

With this information posted on it, the chart comprises a graphic picture of work at hand. As various difficulties are remedied, they are posted on the chart, forming a record of maintenance tasks completed.

The chart is a great aid in scheduling maintenance work. Foreman can select jobs in one vicinity for completion and cut down on lost travel time.

As the pipe-to-soil potential and the current flows are recorded on the chart, certain trends become apparent. For instance, the first indication of a casing short may be a change in pipe-to-soil potentials at a road crossing. The corrosion engineer can make detailed studies to pinpoint the short and he then notes his finding on the strip chart. Then it is up to the pipeline foreman to schedule corrective measures at his convenience.

How Pipeliners Take Readings from Test Leads

One of the most important advantages of this system of operation is that pipeliners receive a certain amount of training in the field of corrosion. Among other things, they learn how to take readings at test leads.

To facilitate this task, Transco designed a test kit with a built in memory. The kit is of stainless steel and makes a neat, convenient sized package. In it

is a potentiometer and copper sulfate electrode.

To take a reading, just balance the potentiometer to zero. Later you can press a button on the instrument and it will repeat the potential reading. This convenience makes it possible for the pipeliner to wait until he returns to the office to report the reading.

Other Uses of the Charts

Several Transco pipeline foremen use the chart to keep a running tally of the population count adjacent to the line. This, of course, will effect looping and pipeline repairs within the area.

Periodically, charts in the field are sent to Transco's Houston, Texas, offices where information on field copies is transferred to original drawings of the chart. A complete set of prints of the corrected charts is hung in the chief corrosion engineer's office and in the office of the superintendent of pipelines. Prints of individual divisions are returned to the field and posted in various divisions and districts.

It goes without saying that this system of operation would never have become successful without complete cooperation and enthusiasm on upper levels of supervision. Transco officials recognize that the corrosion engineering department has both design and operational functions. The chief corrosion engineer sits in on top level operating meetings and works closely with the superintendent of pipelines for better line maintenance.

There has been much talk of the great increases that have come about through automation. Probably a large portion of the increases have come not through the instruments and controls as such but rather through their ability to make labor and technical personnel more effective. Just as important as the instrumentation in production increases is the recognition given in recent years to leadership and supervision. Transco's new set-up described here is one excellent example of the latter. ★ ★ ★

Test Console Shows Status of Microwave System at a Glance

Fault location and switching equipment, carrier terminals, telemetering receivers, and VHF controls are incorporated into one compact unit

Fred S. Jones, *Communications Superintendent, Platte Pipe Line Company*

PLATTE Pipe Line Company has installed a microwave test console in its Kansas City multiplex center that is unique in many technical aspects, and the first of its kind to the best knowledge of company communications personnel.

The console was constructed from standard parts and interconnected with the multiplex racks, which contain fault location and switching equipment, carrier terminals, telemetering receivers, and VHF control equipment. By incorporating these into one compact console, the microwave supervisor can now determine the status of the entire system "at a glance," thus increasing his efficiency and saving considerable unproductive "mileage."

The upper left panel in the accompanying illustration, contains indicator lights, which flash coded signals to indicate which repeater is in the circuit at individual repeater stations along Platte's 1000-mile system. Flashing lights also reveal operation of emergency generators or failure of tower lights. Selector switches on the lower part of the same panel facilitate two-way switching of any repeater in any one of four back-to-back repeater strings.

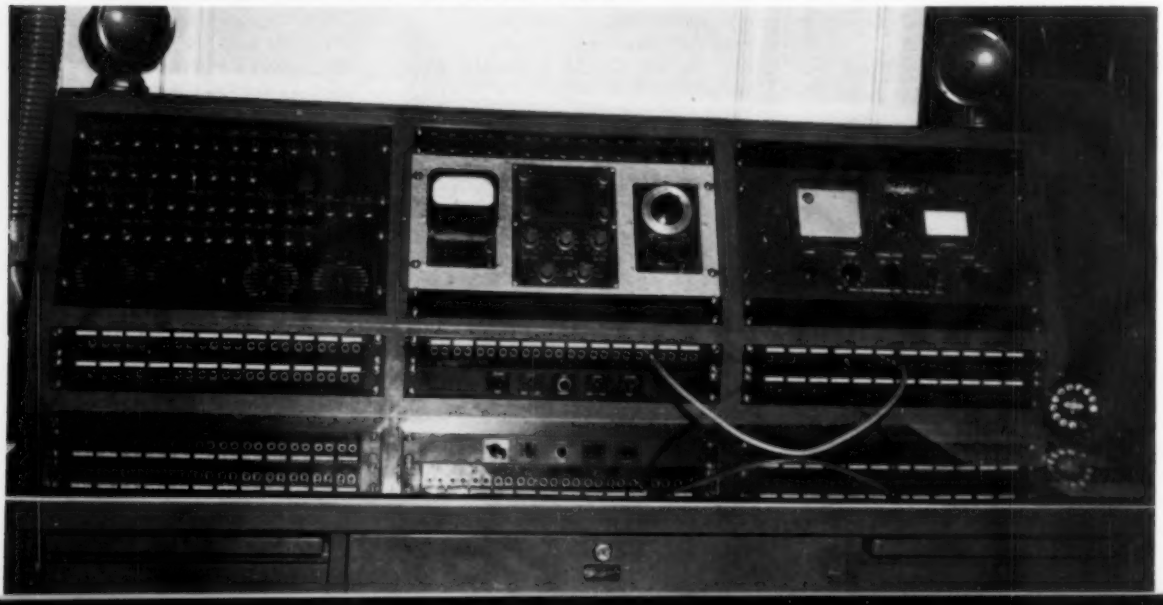
Center panel contains the test equipment necessary for routine measurements of carrier and audio levels on the system. The upper row of lights parallel one telemetering receiver for each pump station to indicate the condition of telemetering channels.

Panel on the right contains the conelrad monitor, which automatically disables the VHF keying sub-channel during conelrad alert periods.

Jack fields are interconnected with the multiplex and test equipment, which facilitates the "patching" of test equipment into any circuit on the system.

The service channel terminates in the console to allow the supervisor to talk to all area technicians on a party line basis. Speakers allow the area technicians to page the supervisor. ★ ★ ★

Microwave test console recently installed by Platte Pipe Line Company.



SELECTED CORROSION LITERATURE

... A Continuing Series

Corrosion And Cathodic Protection

H. V. Beezley
G. R. Olson
United Gas Pipe Line Company
Shreveport, Louisiana

What causes corrosion and how is it controlled?

Corrosion Principles

All corrosion is associated with the flow of electricity. Wherever an electric current leaves a metal to flow into a surrounding electrolyte, corrosion occurs. This is direct current electricity such as that which flows from the battery of an automobile. Electricity in this case flows constantly in one direction. Alternating current, such as that generated by most utility companies and used to light our homes, causes practically no corrosion.

In order that we may understand the corrosion process and its control with cathodic protection, it is necessary to know the general meaning of three electrical terms:

(1). Voltage or potential: These are terms used to denote the electrical pressure that causes electricity to flow. Unit of measurement for this electrical pressure is "volts" similar to the unit of measure for gas pressure, which is "pounds per square inch." Just as we might say that the pressure in a gas line is 120 lb, we would say that the potential of a wire is 120 v.

(2). Amperes: This is a term used to denote the quantity of electricity flowing. Just as we might say that a water line is carrying 10 gal of water per second, we would say that a wire is carrying an electric current of 10 amp.

(3). Ohms: This is a measure of the resistance to the flow of electricity similar to the resistance a pipeline offers to the flow of oil, gas, or some other fluid. If an electric current of 10 amp is being caused to flow by an electrical pressure of 20 v, we say that the resistance is 2 ohms, which is obtained by dividing the volts by the amperes. This is merely a way of saying that the resistance to the flow of electricity is such that for every 2 v of potential, 1 amp of current will flow.

One other term that possibly requires defining is "electrolyte." As far as the corrosion process is concerned, an electrolyte is any aqueous solution that will conduct an electric current. In the case of underground corrosion, the soil is an electrolyte since it practically always contains some moisture. It might appear that some soils are entirely dry, but an analysis will show that some form of water is present even though it is not evident to the eye. It has been said that the most arid desert soils contain some moisture.

When corrosion occurs, flow of electric current may be caused by: (1) Galvanic cells, (2) concentration cells, (3) electrolysis, or (4) by a combination of these factors.

If any metal such as ordinary black iron pipe is placed in the soil, there will be a difference in electrical pressure between pipe and soil. This difference in electrical pressure is ordinarily called the solution potential of the metal, and it can be measured by means of a copper sulfate plug and a voltmeter, as shown by Fig. 1.

The copper sulfate plug is merely a convenient method of making stable electrical contact with the soil. For most soils, solution potential of black iron, measured in this manner, will be from 0.40 to 0.60 v, although values outside these limits may be found in some cases. In this case, assume that we measure 0.60 v.

If any other metal such as galvanized pipe, the surface of which is essentially pure zinc, is placed in the soil, it will be found to have a different solution potential with respect to that

Presented at Corrosion Short Course, Instituto Technologico de Monterrey, Mexico, February 1-3, 1956.

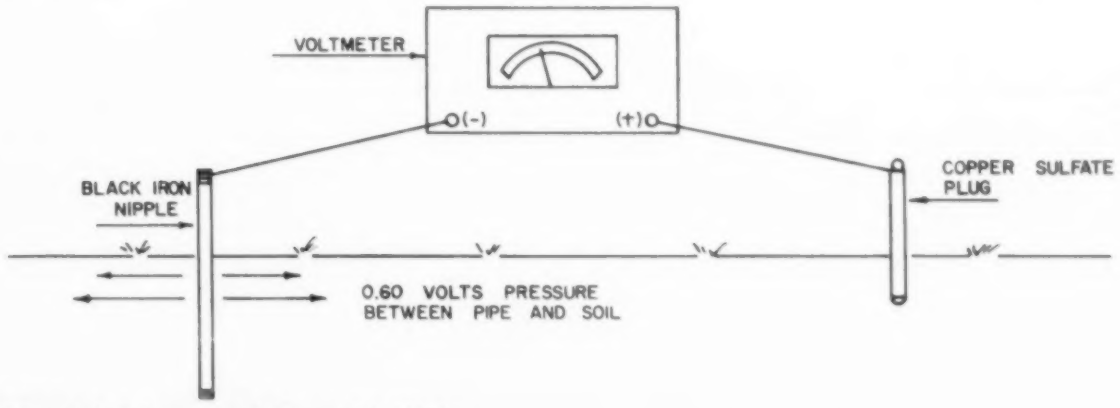


FIG. 1. Method of measuring solution potential of black iron.

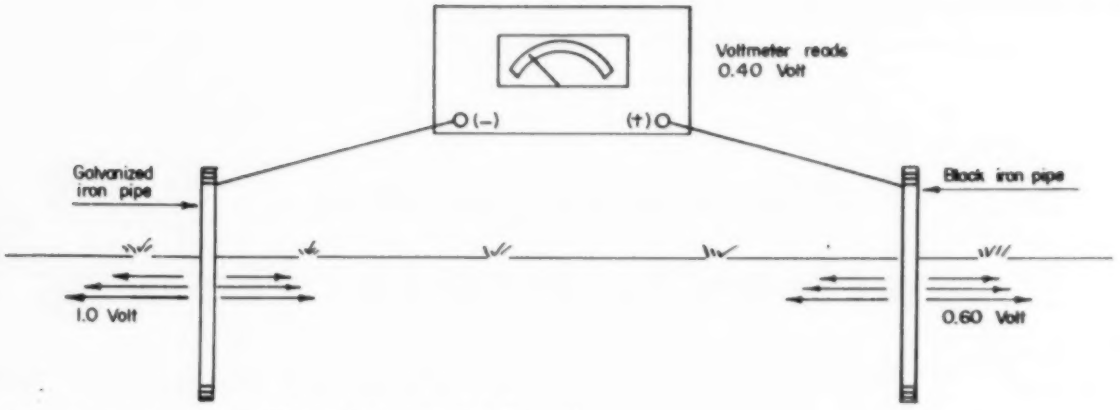


FIG. 2. Measurement of voltage difference between two dissimilar metals.

soil. Solution potential of galvanized pipe in soil as measured to a copper sulfate plug, will usually be about 1 v. If a piece of galvanized pipe is inserted in the soil near the black iron pipe, it will be found that with a voltmeter connected between the two, a reading will be obtained that is equal to the difference in solution potentials between the two metals, as shown by Fig. 2. Assuming a solution potential of exactly 1.0 v for the galvanized pipe, voltage between the two pieces of pipe will be 0.4 v.

Now we have two metals that are each exerting a different electrical pressure upon the soil, one being 0.40 v greater than the other. It is a characteristic of electricity that no current can flow unless a complete path is provided so that the electricity can return to its source. If the two pieces of pipe are placed in the soil, as shown by Fig. 3, with no metallic connection between them, no electricity will flow, hence no corrosion will occur; but if the two pieces of pipe are connected together with a wire, as shown by Fig. 4, a complete path is provided for the flow of an electric current. The galvanized pipe, having the greater solution potential, will discharge current into the soil. The black iron, having the smaller solution potential, will receive this flow of current and the electricity will continue to flow in the direction shown by the arrows.

In this case, we have formed a simple galvanic cell. Corrosion will occur on the galvanized pipe because it is discharging an electric current into the soil. The black iron will be protected from corrosion because of the current flowing onto its surface overcomes any tendency it has to discharge electricity. If these two pieces of pipe are connected together with an ordinary pipe coupling and buried underground, exactly the same type of galvanic cell will be set up, the pipe coupling taking the place of the wire.

In referring to the galvanic cell, the metallic surface that is discharging an electric current, therefore corroding, is usually called the anodic area. The metallic surface that is receiving the flow of current is called the cathodic area. The rate at which corrosion proceeds is dependent upon the relative sizes of the anodic and cathodic areas.

If the cathodic area is large as compared with the anodic area, corrosion ordinarily will proceed at a high rate. To illustrate, consider the case of a black iron screw line that is made up with galvanized couplings, as shown in Fig. 5. In this case, once the current leaves the surface of the galvanized

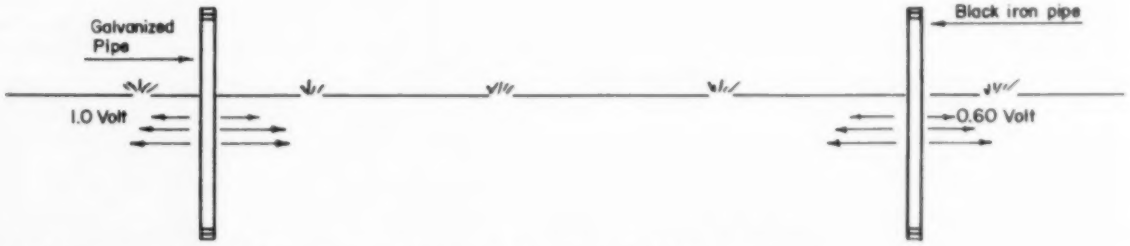


FIG. 3 Conditions under which no corrosion may be expected to occur because of difference between metals.

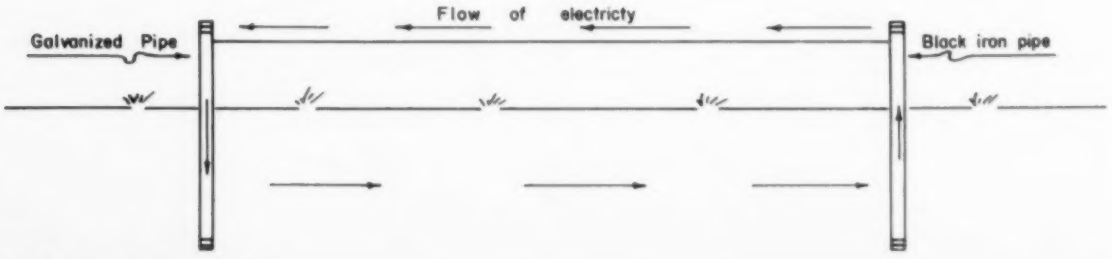


FIG. 4. Formation of a galvanic cell.

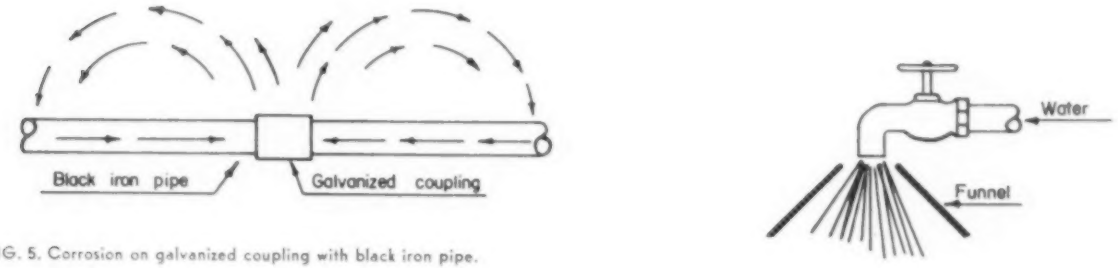


FIG. 5. Corrosion on galvanized coupling with black iron pipe.

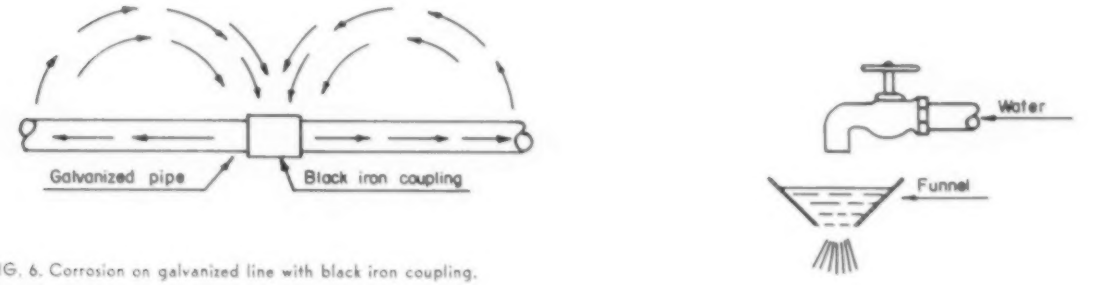


FIG. 6. Corrosion on galvanized line with black iron coupling.

coupling, it has a large area to flow into in order to complete its circuit, consequently little resistance is offered to the flow of electricity.

It is similar to the case of a water faucet inserted into the small end of a funnel, as shown in Fig. 5. Once water leaves the mouth of the faucet, the walls of the funnel offer no resistance to its flow. In addition to the larger amount of current that will flow, corrosion will be more serious in this case because the discharge of electric current is concentrated in a small area. Since the total metal removed is a direct function of the amount of electricity flowing, the coupling in this case will corrode rapidly and may be expected to fail in a very short time.

If the cathodic area is small as compared with the anodic area, corrosion ordinarily will proceed at a slower rate. Again let us consider the screw line. In this case, assume that the pipe is galvanized but is made up with black iron couplings, as shown by Fig. 6. Under these conditions, all electricity that leaves the galvanized surface of the pipe must crowd into a very small area to flow onto the coupling and return to its source. It would be similar to water flowing into the large end of the funnel where the flow of water would be limited by the small opening at the bottom. The seriousness of the corrosive action also would be reduced in this case because the discharge of electricity from the galvanized pipe would be spread over a large area.

Principle of the galvanic cell may be applied to produce useful results, but it always involves a corrosive action on one of the metals making up the cell. The ordinary flashlight battery is probably the simplest form of useful galvanic cell. It is made up of a zinc container and a carbon rod packed in a chemical, as shown by Fig. 7.

If the two terminals of this battery are connected metallically as through a flashlight bulb, electricity will flow from the inside surface of the zinc container through the chemical to the carbon rod and complete the circuit through the flashlight bulb. This will cause corrosion on the inside of the zinc container as you can easily see by inspecting the inside of an old flashlight battery.

Ordinary low resistance soil could be used in place of the chemical with exactly the same results, but the amount of electricity produced would be greatly reduced.

If the solution potentials of a number of dissimilar metals are measured and arranged in the order of their decreasing magnitude, we obtain what is commonly called a galvanic

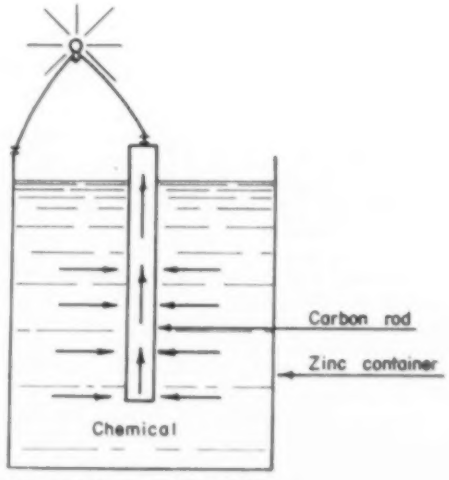


FIG. 7. Ordinary flashlight battery.

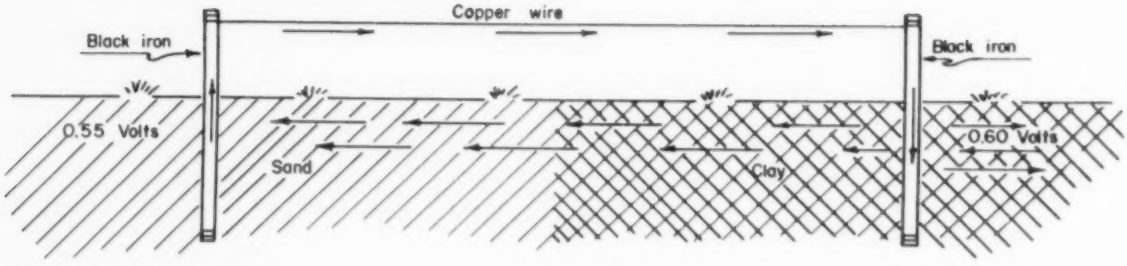


FIG. 8. Concentration cell in soil.

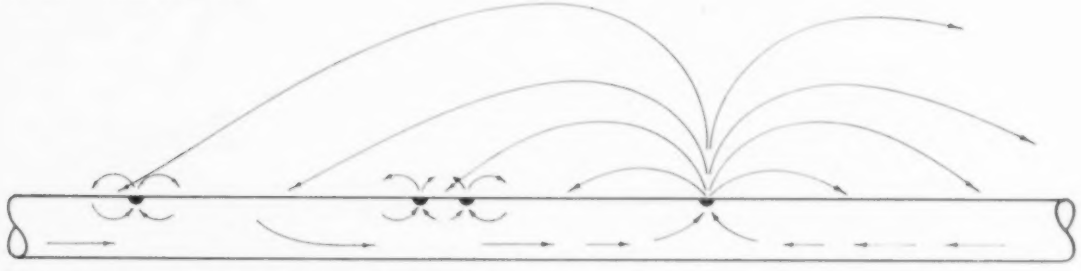


FIG. 9. Corrosion caused by dissimilarities in the surface of pipe.

series. Typical results for a number of different metals in one particular soil are as follows:

Magnesium	1.072 v
Zinc	1.055 "
Aluminum	0.825 "
Bright steel	0.598 "
Bright cast iron	0.592 "
Cast iron	0.574 "
Steel	0.558 "
Lead	0.551 "
Rusty steel	0.335 "
Copper	0.245 "
Silver	0.091 "
Carbon	0.089 "

Keep in mind that these values are those found in only one particular soil. Different values would be found in a different type of soil.

If any two metals are selected, connected together metallically and buried underground, they will form a galvanic cell. The metal higher in the galvanic series, that is, the one having the highest solution potential, will corrode. The greater the separation in the series, the more rapidly will corrosion proceed. If we select the two metals on the extreme ends of this series, such as magnesium and carbon, we have a net galvanic voltage developed of about 1.6 v. In certain soils, which do not offer too great a resistance to the flow of current, it is possible to light a small light bulb with this voltage. In this case, the magnesium corrodes very rapidly.

Most of the corrosion that we are concerned with in pipeline work is caused by differences in solution potentials between metals in the center of this group, that is, within the range of bright steel and copper. You will note that there are appreciable differences in the solution potentials of bright steel, black iron, rusty steel, and cast iron. These four kinds of iron have been frequent offenders in forming very active galvanic cells on underground pipelines. When such a cell is set up, a corrosion leak may be expected to occur within a very short time unless other conditions exist that retard the flow of current generated by the galvanic cell. A familiar example is a well-coated pipe replacement welded into an old line. In such cases, leaks sometime occur at holidays in the coating on the new pipe within only a few months after the replacement is made.

So far, we have discussed only corrosion caused by dissimilar metals. Corrosion also may be caused by dissimilar electrolytes. In the case of underground corrosion, this would mean *dissimilar soils*. If we measure the solution potential of a piece of black iron pipe to clay and then to sandy soil, we will find that two different values are obtained. If a black iron pipe is inserted in sandy soil and another black iron pipe inserted in adjacent clay, and if the two are connected together as shown by Fig. 8, a concentration cell is formed. Assuming that the potential of the iron to clay is 0.60 v and to the sand, 0.55 v, corrosion would occur on the pipe in the clay since the higher solution potential exists at this point. An electric current would flow as indicated by the arrows.

Concentration cells in soil may also be formed by differences in moisture content, in degree of aeration, differences in texture, or any other way in which dissimilarities of the soil exist.

It has been shown that corrosion cells are formed by differences in solution potentials, which cause an electric current to flow with resulting corrosion at points where current leaves the metal. This flow of electric current may also be generated by some source external to the metal under consideration. Stray direct currents in the soil may be picked up by a pipeline, carried for some distance, then discharged back into the soil. At the point where this current is discharged into the soil, corrosion occurs. This is called "electrolysis" and the corrosive action is the same as that occurring from galvanic cells or concentration cells.

Although corrosion cells are sometimes formed with a driving force of 0.20 v or more, as may be the case if new pipe is welded into old rusty pipe, a large part of the corrosion on pipelines is caused by cells that generate only a few thousandths of a volt. This corrosion causes a steady deterioration of the pipe walls, but it may not proceed rapidly enough to invite serious attention until the pipe is in such condition that extensive replacements are required.

Fig. 9 illustrates one way in which corrosion cells are formed on pipe. Ordinary commercial steel, as obtained from the factory, has dissimilarities on its surface of sufficient magnitude to cause the formation of galvanic cells. These dissimilarities are due to mill scale as well as stresses set up in the manufacturing and handling of the pipe. Arrows indicate flow of electric current.

Continued Next Issue

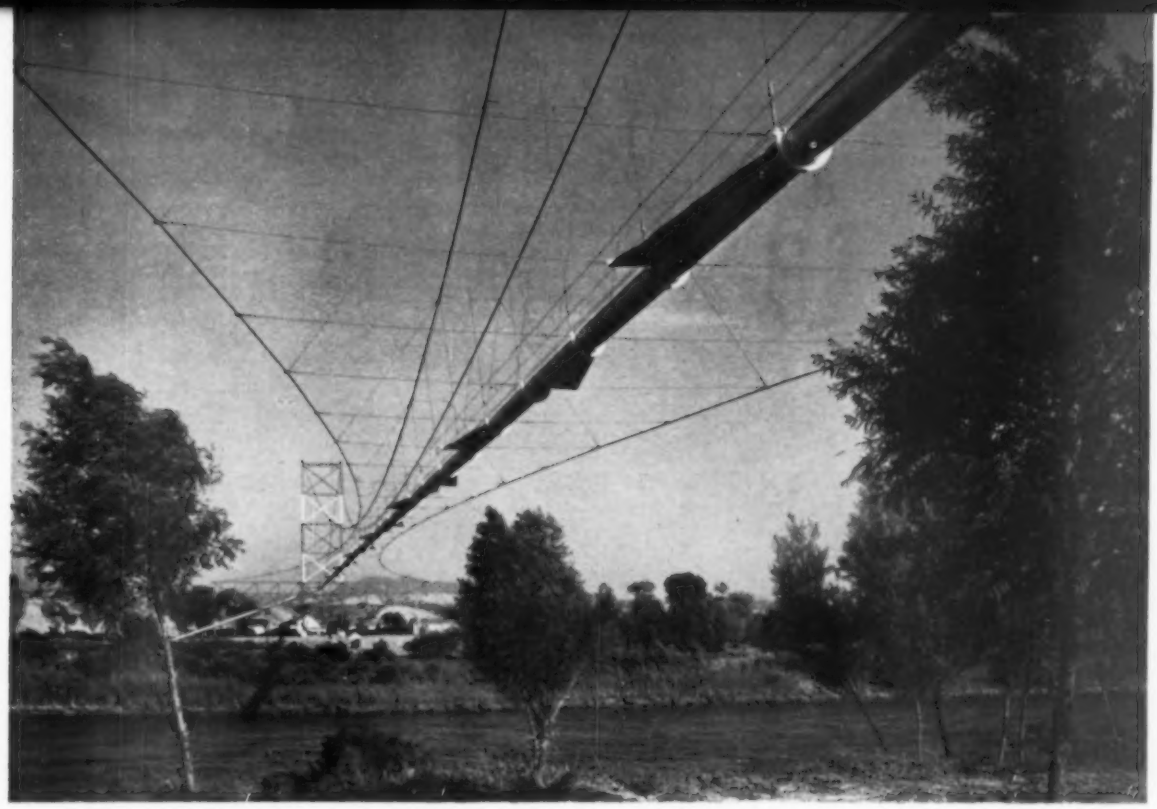


FIG. 1. Vibration damper system on Colorado River crossing. P 615.381

Pipeline Bridge Vibration —cause and cure

Wind-induced vibration is controlled by aerodynamic damper panels

Raymond C. Baird
Consulting Engineer
Santa Monica, California

SEVERAL years ago the writer was involved in a study of suspension bridge vibration with the objective of devising a simple and inexpensive cure for the phenomenon.

The cause of the vibration at first was not apparent because of the low wind speeds associated with it and several types of measurements were made before it was pinned down to an aerodynamic origin. At the time, 1948, little had been published describing such a basis for the vibration of large mechanical structures such as pipeline suspension bridges. The experimental work and the resulting solution to the problem have been since described in ASME papers.[1,2]

Since the first investigation, however, anti-vibration work on other bridges has given a perspective to the problem that will be of interest to persons concerned with the general subject of flow-induced vibration. In addition to a discussion of the problem, this article describes a design change that has been incorporated recently in the aerodynamic damper panels invented to handle the original requirement, and presents damper cost data.

Colorado River Crossing

Fig. 1 shows the appearance of the 30-in. diam, 1020-ft span of the Colorado River crossing of the California line owned conjointly by El Paso Natural Gas Company, Southern California Gas Company, and Southern Counties Gas Company. The view is from the California side of the river. This crossing is a few miles from Blythe, California.

The saw-tooth aerodynamic paneling that now prevents vibration of the structure is readily apparent in this view. The vertical-plane vibration eliminated by these panels had at times reached peak-to-peak amplitudes of 5 to 6 ft at a wind velocity of only 4 to 6 mph.

Fig. 2 illustrates the general appearance of the vibration in its various modes. At times, more than one mode was observed to be present, creating a somewhat confusing pattern of motion.

Energy Source

The cause for wind-induced vibration lies in the dynamic interaction of wind flow with the obstacle presented

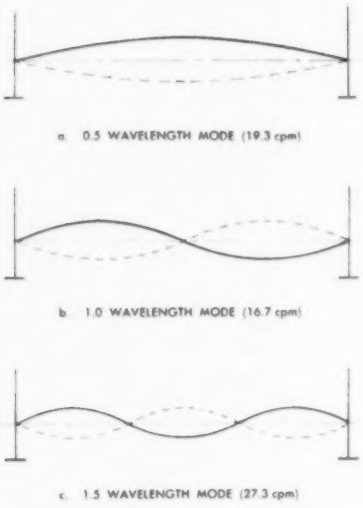


FIG. 2. Oscillation modes of Colorado suspension.

by the suspended pipe itself. This interaction causes the shedding of "whirlpools" or vortices (von Karman Effect) on the downwind side of the pipe, the vortices alternating in the sense as illustrated in Fig. 3. The shedding process is attended by a variation in wind velocity from top to bottom of the pipe, V_1 to V_2 and V_3 to V_4, which, by virtue of the Bernoulli Effect, gives rise to an alternating static pressure differential F tending to move the pipe up and down. When the frequency of this alternating force is close to the natural frequency of one of the bridge's vibrational modes, a vibration will be produced that will increase in amplitude until the energy input derived from vortex formation equals the energy loss due to mechanical hysteresis, friction, and viscous drag attending the motion.

Because of the vibrationally redundant nature of a suspension bridge, the modes do not necessarily bear a harmonic relationship as in the case of a violin string. The frequency disparity is particularly evident in the case of the Colorado River crossing, as indicated in Fig. 2. Thus, even though the frequency of the aerodynamic stimulating force is proportional to wind velocity, it is quite possible to excite more than one mode of vibration for a particular velocity. This is qualitatively illustrated in Fig. 4, which shows overlapping of stimulus regions for different modes.

It should be noted in Fig. 4 that the range of wind velocity in which stimulation results for a particular mode of oscillation is dependent to a large extent upon the amplitude of the motion itself. This is due to the effect oscillation has on vortex formation rate and is analogous to the broadening of selectivity curves associated with tightly coupled electrical circuits. Thus, to excite motion, the wind speed must be closely in "tune" to one of the natural frequencies of the suspension.

After a small amplitude of motion has been achieved, the wind speed becomes less critical and the stimulation for maintaining the motion can still be present if the wind velocity changes. This result is illustrated in Fig. 4 by the bulb-shaped curves for the three modes but is, however, to be considered strictly hypothetical.

It would have been nice from a researcher's standpoint to have acquired data for drawing the actual curves. The moral that applies here is for the experimenter not to solve his problem until he has finished enjoying it. Nevertheless, the observations made at the Colorado crossing indicate that Fig. 4 is indeed a representative, although qualitative, picture of aerodynamic response to a mechanical structure capable of large scale vibration.

Wind

A prerequisite for aerodynamically induced vibration is the right kind of wind. To most people wind is just wind, and usually an annoying aspect of atmospheric circulation, but to an investigator of a problem having to do with air motion, it comes in all shapes, textures, and sizes.

Thus, in the case of a pipeline suspension bridge, not only must it be of a particular velocity to give a resonant vortex shedding rate, but it must also be free of turbulence and be directed at right angles to the pipe axis.

The fact that a river bed is the terrain lowpoint, coupled with a meteorological situation peculiar thereto, results in a situation where steady right-angled wind is frequently produced regardless of the wind direction on either side of the river. This effect is illustrated in Fig. 7 by the arrows representing wind direction and is especially noticeable for a river bed having a wet surface, in contrast with a dry wash.

A typical bridge site, therefore, is a place where a suspension bridge should not be located with regard to the frequent occurrence of vibration-inducing wind, a rather odd situation. Arranging to have the bridge axis 10 to 20 deg away from the perpendicular to the river bed axis doubtless would de-

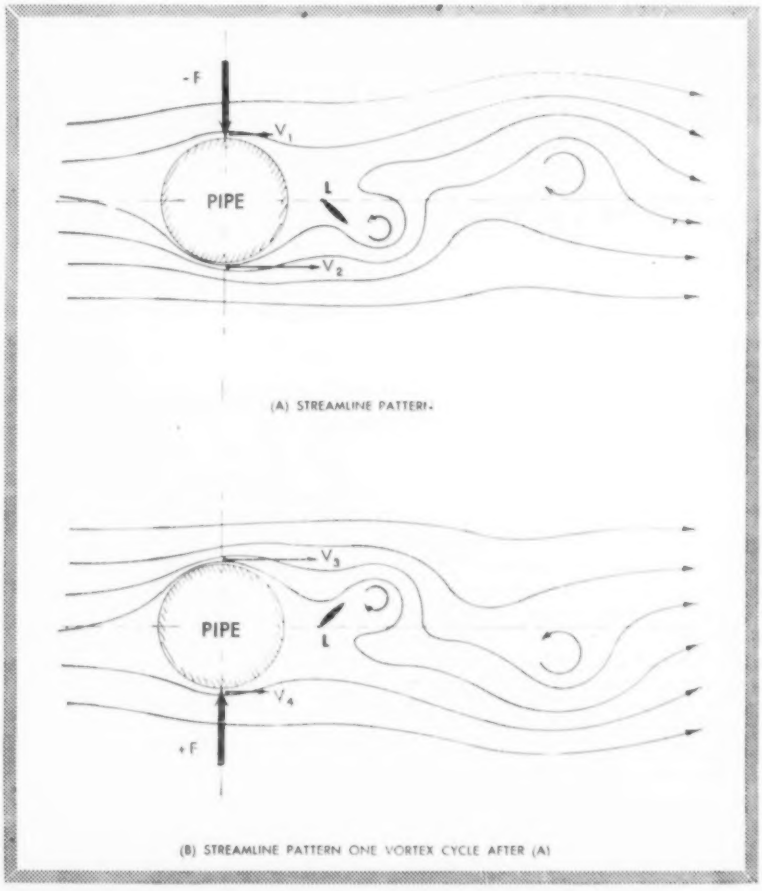


FIG. 3. Generation of vibrational forces.

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crease vibration tendencies. Such an angular relationship is indicated in Fig. 5 as O.

The Problem and Solutions

Since for a typical pipeline suspension bridge the vibration-inducing forces can be shown to be of low magnitude, simple tie-down schemes seem attractive until one recognizes the potential dangers to the structure they can present. Practically, the problem boils down to the overcoming of low-intensity vibrational forces without introducing anything that will adversely affect the static strength requirements of the bridge.

A method that has been used with much success involves the application of diagonal suspender cables. This method is reasonably inexpensive and can be used to achieve almost any degree of structural damping.

Another approach, conventional except for the size of the equipment required, is the application of the Frahm type vibration damper. As a matter of fact, such a device was designed for the Colorado crossing but was never applied. Its chief drawbacks are: (1) Manufacturing cost, (2) installation and adjustment expense, (3) need for regular maintenance, and (4) ability to handle but a single mode of oscillation.

Fundamental Solution

The solution to the problem as originally applied to the Colorado River bridge (Fig. 1) operates to destroy the vibration inducing forces themselves. This is accomplished at little expense and without adding potential danger to the structure. The solution resulted from taking a circumspect, although a perhaps naive, look at the simple equation linking vortex formation rate with wind velocity and dimension of the obstacle. This equation is:

$$f = k\,(v/d)$$

where f is the frequency of vortex formation, k is the constant of proportionality (Strouhal Number), v is the velocity of incident fluid flow, and d is the dimension of the obstacle in the direction of flow. Little regard was given at the time to the range of Reynold's Numbers involved, as it appeared to be a secondary consideration for this particular problem.

It was reasoned that if either v, d, or both, could be varied from point to point along the pipe, the vortices and their associated Bernoullian differential forces (Fig. 3) would be so widely distributed in frequency that stimulation of the bridge into vibration at any of its natural frequencies would be impossible regardless of the wind velocity. It was obvious that varying v would require appurtenances that might result in structural danger at high wind veloc-

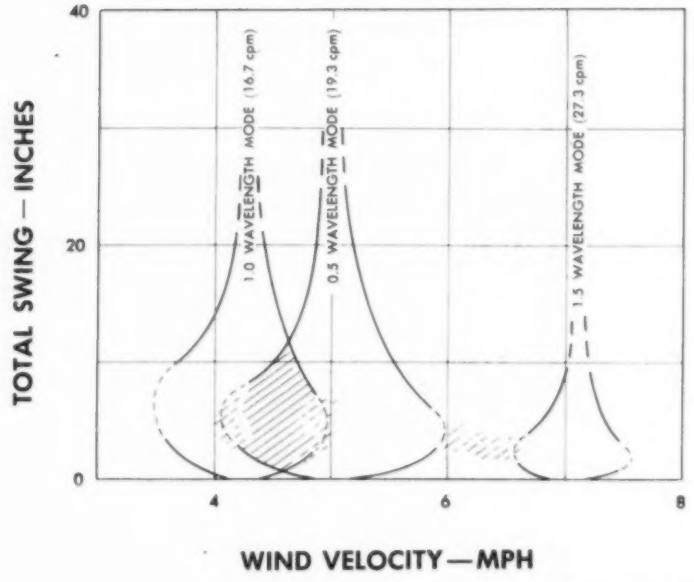

FIG. 4. Vibration amplitude versus wind velocity (hypothetical).

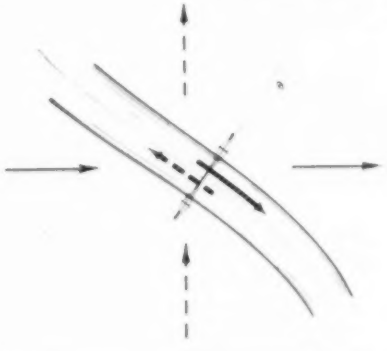

FIG. 5. Wind-direction change at river.

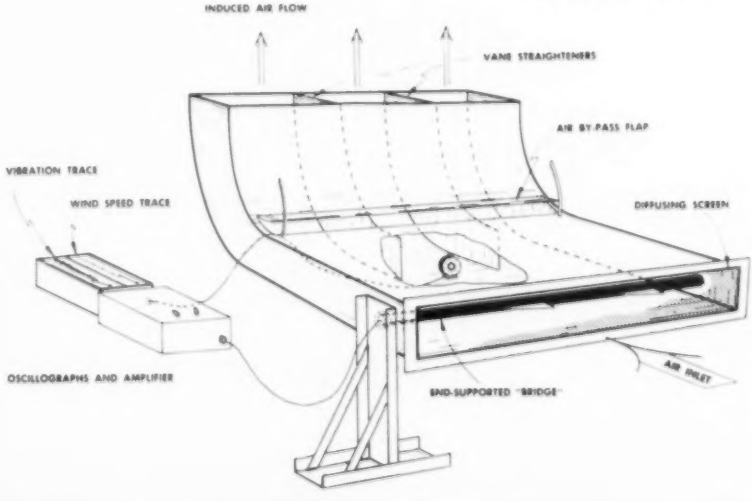

FIG. 6. Apparatus for testing vibration damper.

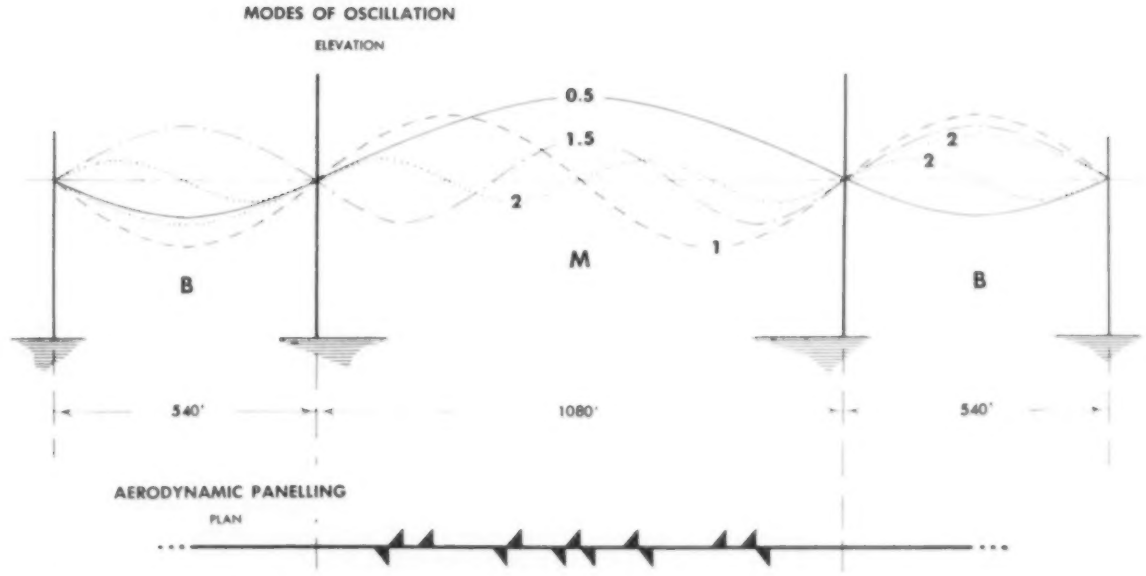

FIG. 7. Bridge vibration modes and damper arrangement, Gila suspension.

ities, whereas varying d by means of tapered fins would not.

H. G. Loos of the California Institute of Technology in commenting on the writer's original paper[1] shed additional light on why the fins later proved to be so effective when he wrote: "... (the) panel addition also means the creation of a sharp edge on an initially smooth surface. Thus, the flow must fulfill the so-called Kutta condition at the trailing edge, so that it leaves this edge smoothly. The consequence of this condition, together with the symmetry of the panel geometry then imposes a considerable amount of symmetry upon the flow in the immediate neighborhood of the obstacle so that the Karman vortex street cannot be realized in that neighborhood but establishes itself farther downstream. This leads to a reduction of the fluctuating forces. Furthermore, the coupling between pipe motion and vortex configuration is also essentially changed because of the addition of a sharp edge. This coupling resembles now, to a certain extent, that of wing flutter problems."

Dynamic Model Tests

Before translating the foregoing theory into engineering design and application to a structure such as the Colorado bridge, it was thought prudent to run some experimental checks of a type that would not affect deleteriously the mental equanimity of pipeline gas dispatchers. Not only this, but such experiments provided the only approach whereby the gas companies could be convinced of the utility of the proposed aerodynamic vibration damper.

A rectangular wind tunnel was devised, as shown in Fig. 5, in which was placed a model suspension bridge reduced to its most elementary form. Strain gages were used for measuring vibration. On this "bridge" various arrangements of aerodynamic paneling were tested. It was only on the basis of clear-cut positive results from these experiments[2] that the gas companies decided to install a damper system on the Colorado suspension bridge.

Engineering and Installation

The solution of a problem such as this, for psychological, political, and practical reasons, is more often than not a one-shot affair. You have only one opportunity to prove the soundness of an idea, particularly if the idea is new and there are other potential solutions for consideration.

To the uninitiated full scale design of a laboratory prototype ought to be a simple procedure, especially when it involves a mechanical contrivance so straightforward appearing as saw-tooth shaped panels. However, even after arriving at a full-scale size for the panels, an estimate of the number needed, and their placement on the bridge, it was realized that success or failure would still depend on good mechanical design.

Accordingly, the design was established by means of a full-scale mock-up on a piece of 30-in. pipe. Needless to say, the original paper conception had to be altered in several ways. Following this, the panels were constructed and installed on the bridge using a boat to carry the panels to points underneath their projected locations on the span.

The Author

Raymond C. Baird, a graduate of UCLA, Caltech, and the Army Command and General Staff School, was an Air Force meteorologist for six years during World War II, and is a registered mechanical engineer. His early industrial experience in vibration, acoustics, and fluid flow came as a member of the Fluor Corporation research staff with the help of two mobile research laboratories. He has patents in the fields of vibration, acoustics, fluid flow, electronics, and heat exchange, and has authored numerous technical articles and papers. (He was co-author of the recent *Pipeline Engineer article* "Practically Noiseless Plant," July 1956.)

Baird has been active as an independent consulting engineer for several years in plant design and problems related to acoustics, vibration, and fluid flow.

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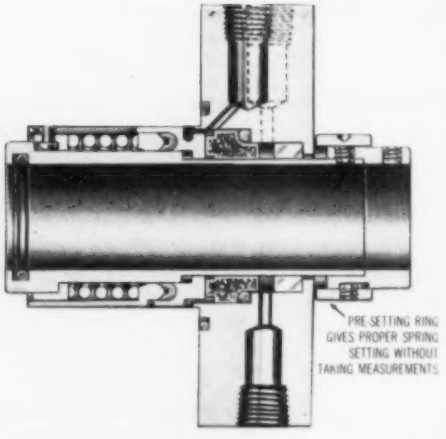

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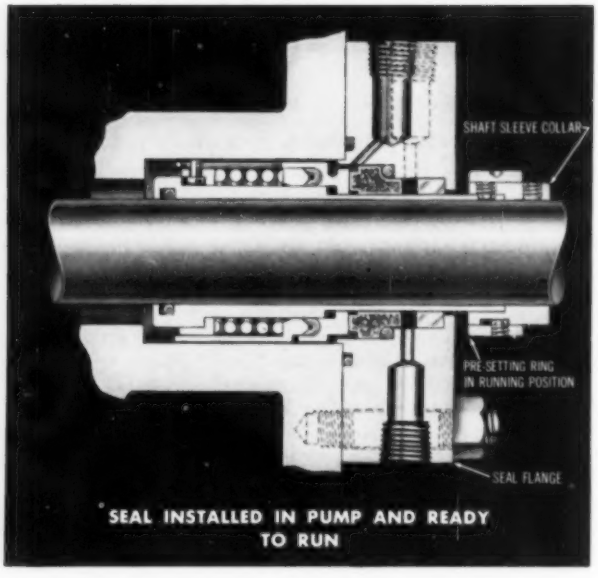

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FIG. 8. Stubbed vibration damper panels.

Results

The effect of the aerodynamic damper system in rendering the Colorado crossing insensitive to wind was almost too good to be true. Not only was vibration at the low wind velocities eliminated but winds of 90 mph or more had no damaging effect on the fins, or, more important, the structure plus the fins. The damper system has now been operating for a period of more than three years with no maintenance requirement, except for infrequent inspection of bolting. Application of this vibration damper is covered by patents owned by the Flour Corporation of Los Angeles.[3]

Other Bridges

The fin technique has been successfully applied to other bridges at least one of which is larger than the Colorado River bridge. This is the 26-in. Gila crossing also on the El Paso Natural Gas Company California line.

The Gila bridge has a main span of 1080 ft plus two back spans of 540 ft each. In analyzing the vibrational characteristics of this structure, necessary to insure the greatest deadening effect with the fewest number of fins, it was determined that four modes were potentially present that easily could be induced to occur by wind action. These harmonically-related wave patterns are illustrated in Fig. 6. Typically, the corresponding frequencies lacked harmonic relationship, as shown in the following table.

Mode	Frequency (cpm)	Stimulating Wind Velocity (mph)
0.5	14.3	3.1
1	19.8	4.2
1.5	23.8	5.1
2	35.2	7.5

It was estimated that 13 panels distributed along the main span, as indicated in Fig. 7, would be sufficient. In this it was considered that the effect of topography on wind flowing over the end spans would render their effect in producing vibration negligible.

Shortening the Panels

The results of the Colorado installation indicated that there would be little loss in damper effectiveness by "stubbing" the narrow end of the taper, the discontinuity in width so caused more than making up for the loss in tapered length. The resulting fins, as installed at the Gila crossing, are stubbed and appear similar to those shown in Fig. 8, which picture was taken later of the altered panels on the Colorado bridge. This alteration in design cuts cost of both manufacture and installation. Most important, however, is the fact that the Gila bridge is now aerodynamically dead.

Cost

Complete cost for the damper system as installed on the Colorado River crossing amounted to $8270. This included fabrication, installation, inspection, and management.

Since the Colorado installation was the first of its kind, a more accurate expense figure stems from the Gila installation, which utilizes stubbed panels and incorporates certain structural improvements. For it, the total cost to the El Paso Natural Gas Company was $7483. This constitutes just about the cheapest comprehensive type insurance known to the writer. Unfortunately, there are not too many individuals in a position to take advantage of it.

References

1. "Wind-Induced Vibration of a Pipe-Line Suspension Bridge, and Its Cure," R. C. Baird, Trans. ASME 77, No. 6, 797-804 (August 1955).
2. "A Damper for Wind-Induced Bridge Vibration-Experimental Studies," R. C. Baird and A. J. Ebersole, presented at ASME Petroleum Engineering Conference, Los Angeles, California, September 1954. Paper No. 54-Pet-11.
3. U. S. Patent No. 2,659,913—Canadian Patent No. 508,360.

★ ★ ★

Canadian News Notes

Sask Power Expands. An immediate enlargement of the program of 1957 construction by Saskatchewan Power Corporation, the provincial gas distribution authority, will be undertaken as a result of the decision on April 3 by the Alberta Government to permit export of gas from eastern Alberta fields for the use of SPC in its home province.

The application by SPC for permission to use gas from the Many Island field in Alberta was made necessary because the Hatton field on the Saskatchewan side of the provincial boundary forms a common reservoir with it. Producer contracts had already been signed, subject to Alberta's approval.

The projected program involves construction of a main trunk line of 12-in. or 16-in. diam from Hatton to the Success gas field. This line would provide an auxiliary source of supply for the existing trunk line between Success and Moose Jaw and would also permit construction of an extension to Regina.

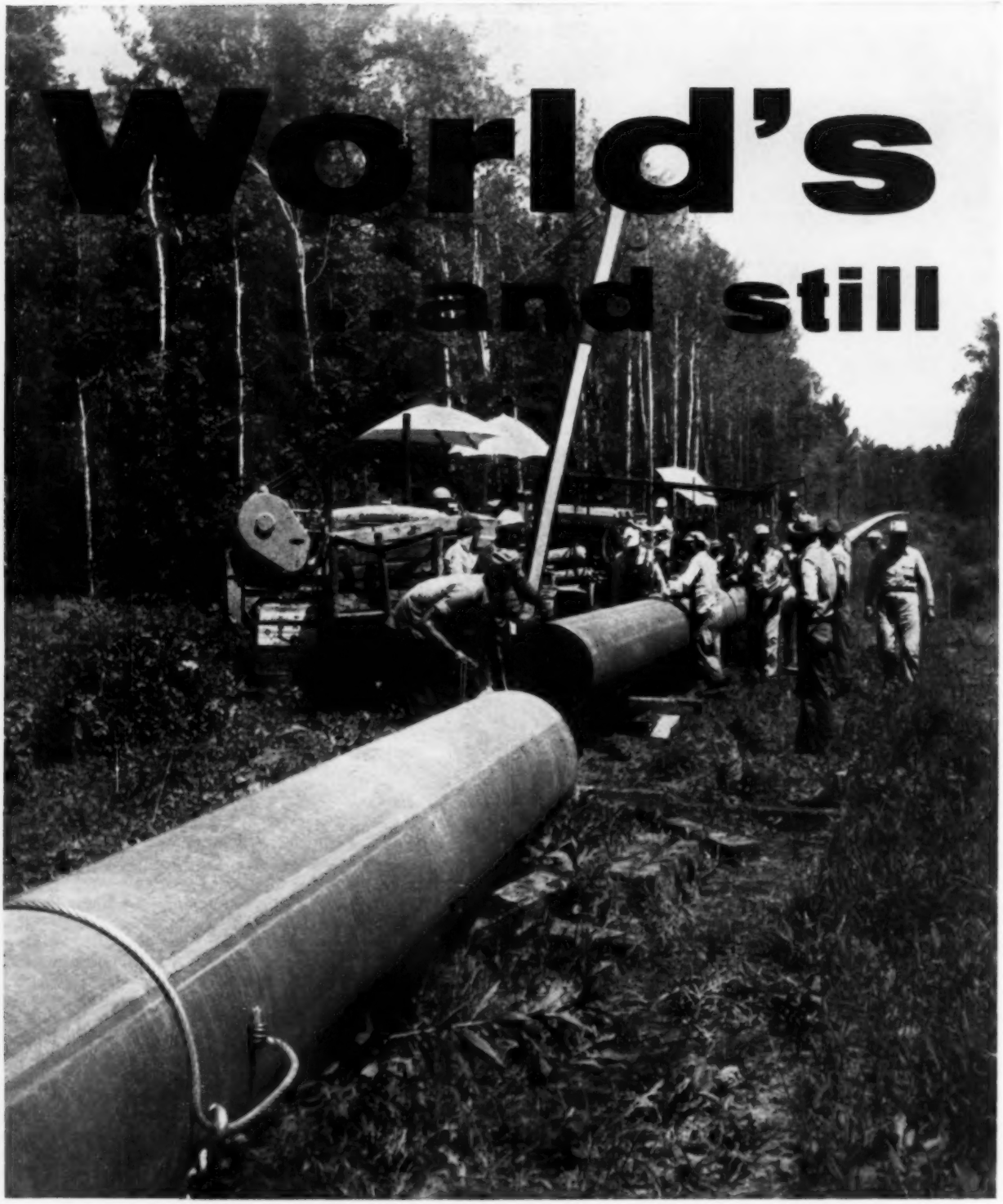
Meanwhile, Regina will draw gas from the Trans-Canada line for 1957-58, as SPC does not expect to be able to lay the entire additional system this season. The amount of reserves covered by the conservation board recommendation is 895 billion cu ft. More than two-thirds of it is in Alberta.

Crown Line. Brushing contracts have been awarded by Northern Ontario Pipe Line Crown Corporation, which will build the section of the natural gas pipeline across northern Ontario to be leased under purchase option to Trans-Canada Pipe Lines, Ltd. The 310 miles between the Manitoba-Ontario boundary and Port Arthur have been divided into five sections of about 60 miles.

Harris Construction Company, Ltd. of Winnipeg has been awarded sections A, B and C, which run in geographical sequence from the boundary. Patricia Transportation Company, Ltd., of Winnipeg has section D, and Zechner-Mundt Company of Nipigon, Ontario, has section E, which terminates at Port Arthur.

TCPL River Crossings. Marine Pipeline & Dredging, Ltd., of Vancouver, contractor for all three river crossings on the Manitoba portion of the Trans-Canada line, has a crew on the site of its third job, the crossing of the Red River at St. Norbert, 12 miles south of Winnipeg. No attempt will be made to ditch, however, until the spring flood water has gone down. Hubert Proctor is the assistant superintendent in charge of this job.

The crossing consists of twin 1000-ft sections of 34-in. pipe.



Interprovincial has extended their system from Superior to Sarnia and now from Sarnia to Port Credit, Ontario by the end of this year. It will then include over 3,000 miles of main line and loops. A. O. Smith's contribution to the system will be just above 50% of the total line laid.

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longest growing!

Interprovincial Pipe Line Company has 1,774 miles of main line now in service . . . will extend this system another 156 miles during '57

THIS is the big crude oil carrier from Edmonton, Alberta, to refineries in the Prairie Provinces and Ontario in Canada . . . Minnesota, Wisconsin and Michigan in the U. S. Spanning 1,774 miles, it's already the world's longest line of this type and construction is now under way that will increase main line length to over 1,900 miles.

A. O. Smith is proud to have been a part of this great system since the original main line of 1129 miles was constructed in 1950. Over 70% of this original line to Superior, Wisconsin was supplied by A. O. Smith. Since that time from both Milwaukee and Houston mills, A. O. Smith has supplied most of the pipe for the looping work done on this original section in 1953, 1954, 1956 and 1957.

Map shows the complete system of main and looping lines as it will be when this year's construction is completed.

On the current project, A. O. Smith is supplying pipe for the looping lines being built near Glenaven and between Clearbrook and Superior.

For almost 30 years...

A. O. Smith line pipe has always been manufactured to a high standard of quality . . . precisely-controlled at every step of production. That's why A. O. Smith pipe, made and installed in 1928, is still in operation. That's why so much A. O. Smith pipe is in nearly every important high-pressure line.

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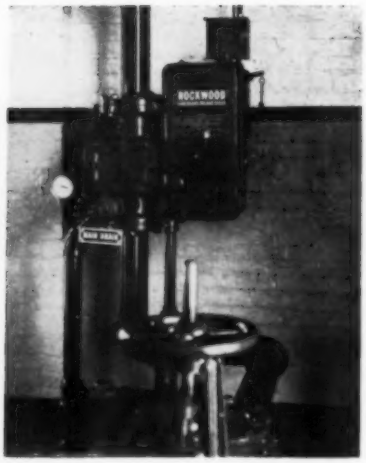
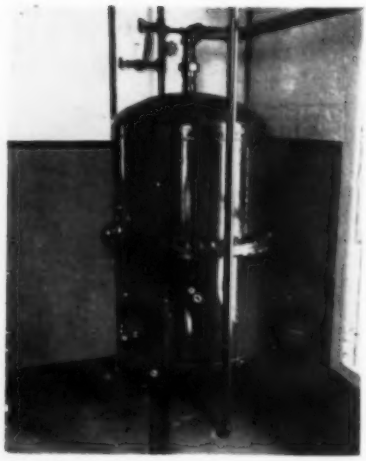
Danger of station fires is remote under present day engineering and construction practices, but Ohio Oil provides for the possibility with . . .



Deluge valve and trip mechanism for the automatic foam system.



Liquid foam tank for the automatic foam system.

Automatic Foam Systems

Kenyon Zimmerman
Safety Engineer
Pipe Line Department
The Ohio Oil Company

Triggered by a rapid rise in temperature, within minutes the system entirely covers a possible fire area with a 4-in. blanket of foam. Normal gradual temperature rises do not actuate the HAD's.

CRUDE oil and products pipeline pumping stations are fast becoming automatic operations. Although the stations are engineered and constructed to eliminate the possibility of a fire, we also plan for the remote danger that exists in every operation handling flammable liquids. Consequently, The Ohio Oil Company is making every effort to protect physical properties with several types of automatic fire extinguishing systems.

This article deals with a foam system installed at Ohio Oil Elwood Station, Indiana.

This robot fireman keeps a 24-hour vigil at the unmanned pump stations and is designed to blanket the possible fire area immediately on any sharp rise in temperature. And what's more, by simply shutting one valve, it cleans up its own mess.

Along its "Big Inch" crude oil pipeline, Ohio Oil has installed similar automatic systems in its stations at Jamestown, Indiana; Martinsville and Patoka, Illinois.

Photos Courtesy The Ohio Oil Company and the Beacon Department.

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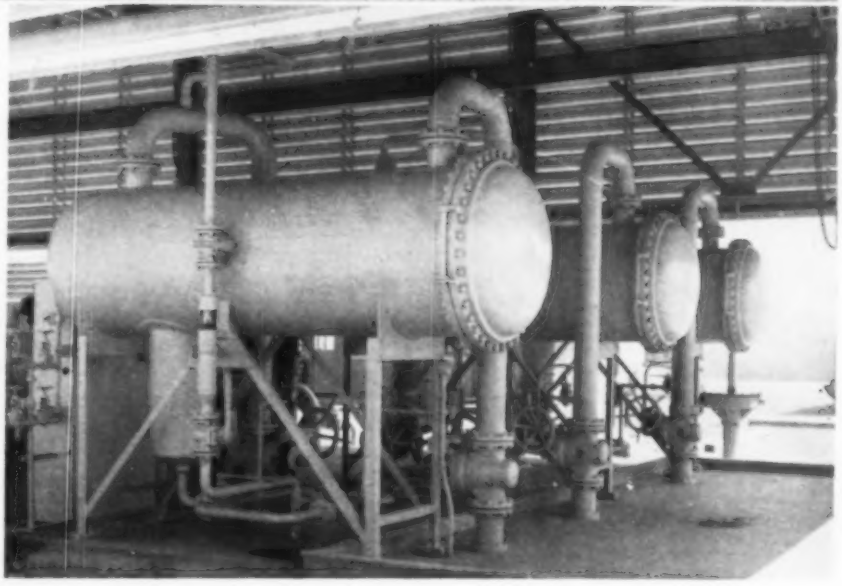

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E. P. Hughes, sales engineer, Rockwood Sprinkler Company, shows 4-in. blanket of tiny, adhesive bubbles formed by foam system.

Ferrel Chancellor, engineer, and Forrest Decker, chief engineer at Ohio Oil's Elwood pump station, examine foam blanket preparatory to clean-up. Clean-up is no strain: Just a turn of the valve and water flows out of the heads to break up the foam, wash the walls and floor, and carry the material down the drain.

Men who conducted a recent periodic test at Elwood are: George Schmitt, Williams & Co., distributor; Ken Zimmerman, safety engineer; James O'Regan, chief engineer, Rockwood; C. F. Firmin, chief engineer, pipeline department, and Hughes.

Elwood station looked like this after the system performed the clean-up cycle. Upper black pipes on the left wall are for foam system. Funnel-shaped nozzles are for auxiliary CO_2 system.

The Author

Kenyon Zimmerman is a veteran with 20 years' experience in The Ohio Oil Company's Pipe Line Department. He started with the company in 1936 on the "silly" end of a shovel on a pipeline maintenance gang, working out of Elwood, Indiana. Several years later he had advanced to station engineer at the pipeline pump station in Sheridan, Indiana, then moved up through assistant chief engineer at Wood River, Illinois, and from 1947 served for two years as chief engineer of the company's Mississippi River barge dock at Jaco Landing near Wood River.

From 1949 to 1953 he was a pipeline land man, and four years ago was appointed safety engineer, Pipe Line Department, headquartering in Ohio Oil's general offices in Findlay, Ohio.

Any one of a series of heat activating devices (HAD's) spotted strategically in the possible fire area actuates the system. A rapid rise in temperature caused by a fire immediately triggers the mechanism: The motor driven pump starts, the deluge valve opens, and foam flows from the heads in the pump room.

Tests prove that in a matter of minutes the system will completely cover the entire areas with a 4-in. blanket of foam. Foam will flow until the supply is depleted. Then the water supply automatically cuts in and the specially designated heads produce water fog until the system is manually shut down.

Clean-up after foam tests is surprisingly simple. The foam liquid supply is shut off and water is flowed through the system. Within a few minutes the fog water washes the walls and breaks up the foam blanket. Broken foam and wash water go down the drains. The system is tested periodically.

A further safety bonus: Operating engineers on a regular schedule use these systems in their housekeeping program. They turn on the system to cleanse the pump rooms and flush all drains to get rid of any oil that might be accumulated in the drain traps.

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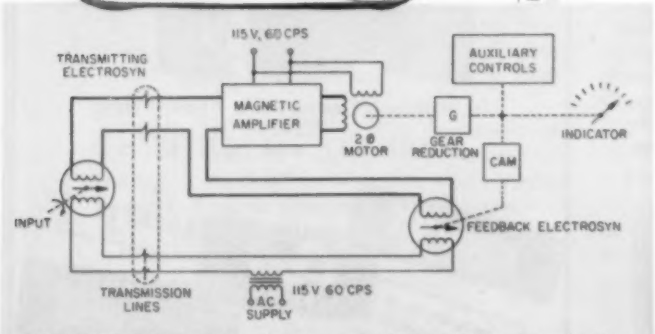
ElectroSyn Pressure Transmitter Model 501



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- *flow*
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Leading pipeline companies are using ElectroSyn systems for remote indication and data handling of pressures and flows because of system's reliability, flexibility and the fact that it can withstand a static overload of 300% of rated pressure for a 1% zero shift. For complete information write for Technical Bulletin B257.

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Tom P. Walker

Clyde McGraw

Walker Chairman, McGraw President Transco

Directors of Transcontinental Gas Pipe Line Corporation have named Tom P. Walker to the newly created position of chairman of the board and elected E. Clyde McGraw to succeed him as president and chief executive officer of the company.

Walker has been president of Transcontinental for the last four years. Previously he had been a vice president of Irving Trust Company of New York in charge of its Utility Department and before that he served as an executive of several public utilities, including the presidency of Gulf States Utilities Company.

McGraw has been executive vice president of Transcontinental since 1955. He has been associated with the company since its inception, serving initially as operating vice president. Formerly with Stone & Webster Service Corporation, he was active in planning and engineering the 1840-mile natural gas pipeline from Texas to New York.

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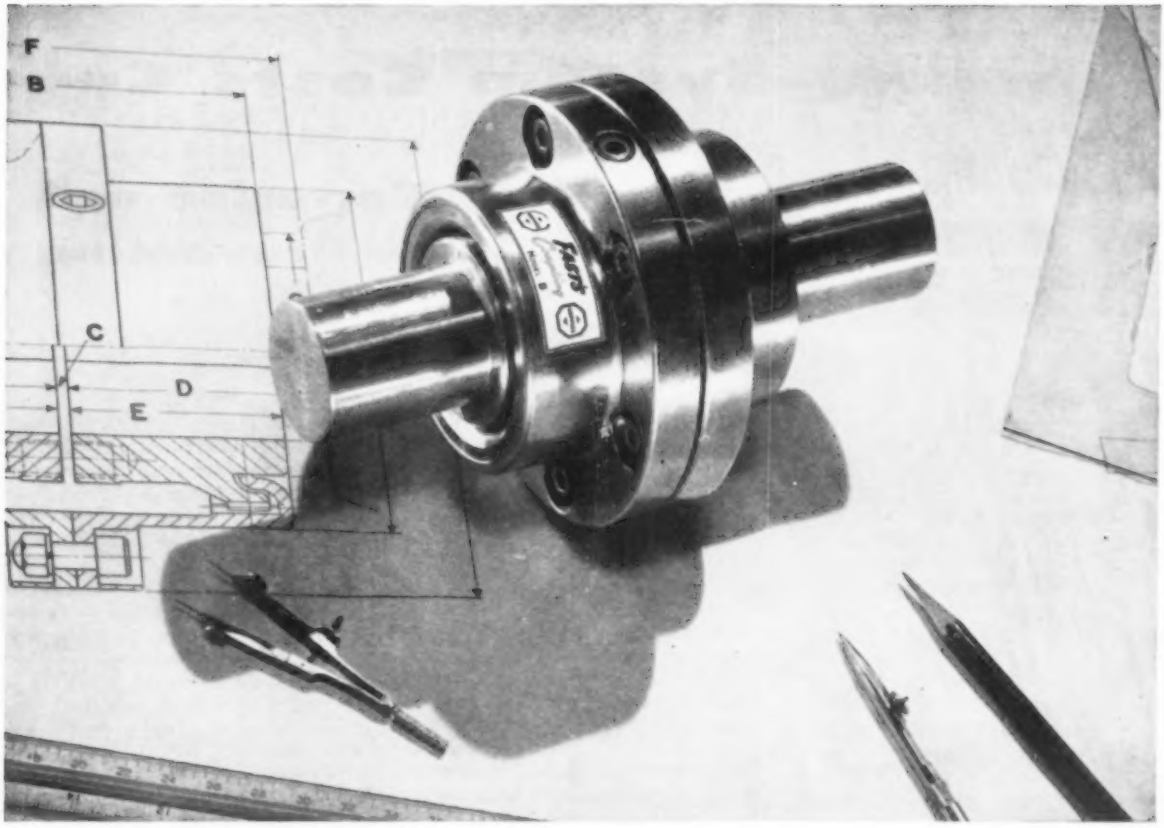

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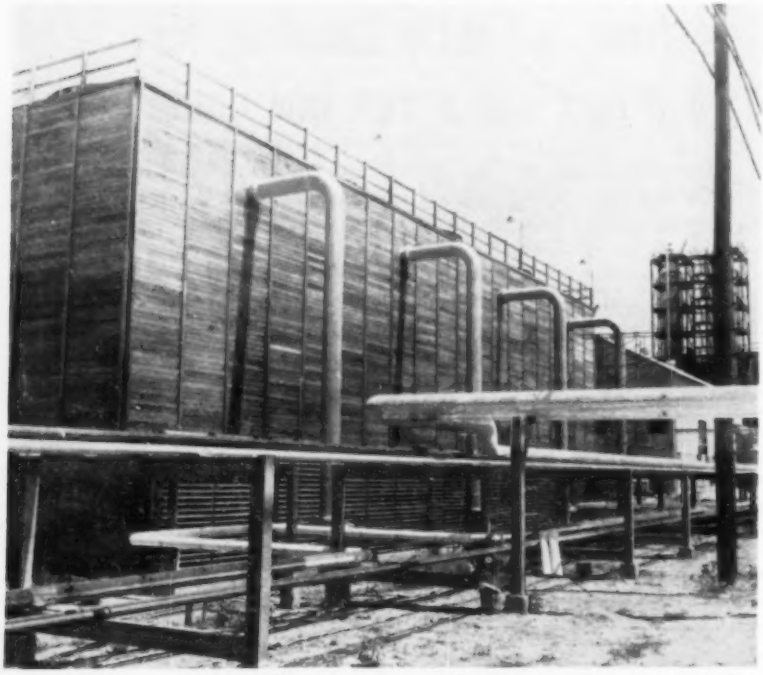
UNLESS treated, cooling-water systems will eventually become afflicted with scale, rust, or corrosion. These actions will seriously impair efficiency to the point where it will become necessary to shut down the equipment to make difficult, expensive repairs or install costly replacement parts. Proper water-conditioning chemicals, however, will eliminate these costly operations.

The amount of scale deposited and the severity of corrosion depend on the characteristics of the water and the operating conditions. Scale accumulation interferes with heat-transfer surfaces, causes high speed pressures, and clogs condensers, spray nozzles, pipes, and valves.

Corrosion, the other enemy of efficient operation, deteriorates and wastes metal. It rusts away the metal, which eventually becomes pitted through; the result is a useless part. Corrosion can also cause congestion in the same manner as scale.

In cooling towers, evaporation and windage cause water loss. The subsequent concentration of solids causes scale, the amount depending on the original condition of the water. Meanwhile, dissolved oxygen and carbon dioxide and low pH cause corrosion.

Scale becomes a major problem in a system when the amount of solids in the water supply exceeds the solubility limit; the result is a condition of supersaturation. Lime scale, which is most prevalent, comes from the breakdown of the bicarbonate in hard water. The breakdown produces calcium carbonate, a relatively insoluble substance.



Evaporation and windage cause water loss in cooling towers. The subsequent concentration of solids causes scale, the amount depending on the original condition of the water. Meanwhile, dissolved oxygen and carbon dioxide and low pH cause corrosion.

(Photo courtesy of J. F. Pritchard & Co.)

The possibilities of both scale formation and corrosion should guide the choice of any treatment. Attention to only one of these problems can cause a severe condition in the other. For example, high alkalinity imparted by a material such as soda ash, which might be applied to overcome acid corrosion, could precipitate heavy sludge and scale deposits.

Variables. The choice of treatment should depend on the many variables encountered, such as (1) the water capacity of the system; (2) chemical characteristics of the makeup water; (3) type of metals; (4) existing scale, corrosion or algae in the system; (5) possible domestic use of water that has passed through the system, and (6) the temperature of incoming and outgoing water.

The existence of algae and slime presents an individual problem requiring special treatment.

The chemist or engineer who makes treatment recommendations should have information about the manufacturer, model number of the equipment, and tons of refrigeration capacity or rate of pump circulation. Added to the preceding data, samples of makeup and circulating water, a resume of the difficulties and/or samples of deposits will provide the basis for effective, intelligent recommendations.

Scale Prevention

Water Softeners. Water softening is often used to control severe scale formation. Most scale deposits in cooling-water systems are of the carbonate type. The permanent or sulfate type of hardness does not affect the problem unless there is an abnormally high concentration of mineral matter. The temperature rise in cooling-water systems does not appreciably reduce the solubility of the permanent hardness

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Kentucky and West Virginia Gas Co.
Mid Valley Pipeline Co.
Natural Gas Pipeline Co. of America
Natural Gas Storage Co. of Illinois
Clinchfield Coal Corporation*
New York Natural Gas Pipeline
Ohio Oil Co.
Pan American Pipe Line Co.
Panhandle Eastern Pipe Line Co.
Sinclair Pipe Line Co.
Texas Gas Transmission Co.
Texas Illinois Natural Gas Pipeline Co.
Richfield Oil Co.
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constituents as would the high temperature used for boiler water.

When softened water is desired for makeup purposes, the carbonates can be removed successfully by a cold lime treatment, which precipitates the calcium carbonate, followed by a treatment with sulfuric acid to convert the carbonates to sulfates. Sometimes the acid treatment can be used without lime pretreatment, or the water can be zeolite-softened.

Although softening is normally successful, the initial expenditure and upkeep can run high. Many times, however, proper treatment chemicals can solve the problem and eliminate the need for pre-softening. Also, softened water will normally be more corrosive than the original water, and a resulting severe corrosion problem will merely have replaced the original scale problem.

Constant Bleedoff and Makeup. In any system where evaporation and other water losses might cause a concentration of mineral matter, it is vitally important to bleed off the old and make up new water constantly. This measure, whether or not other scale-prevention measures are used, will help prevent the deposition of scale. The presence of a suitable treatment, however, allows high mineral concentration before scale formation occurs. Normally, a bleedoff rate equal to the rate of evaporation is sufficient in cooling towers.

Controlled Carbonate Scale. The deposition of a controlled carbonate scale in the cooling system will prevent excessive scale formation. This method employs Langelier's equations, which predict the corrosive or scaling tendencies of water based on its pH, calcium content, total alkalinity, dissolved solids, and temperature. With this method, the pH of the water is adjusted with acid or alkaline components to satisfy Langelier's equations. Careful analytical control is necessary to maintain the desired chemical balance, but when properly adapted to conditions, controlled carbonate scaling prevents both excessive scaling and corrosion.

Surface Active Chemicals. The materials most widely used to prevent scale in cooling systems are chemicals with surface activity. These materials, which include tannins, lignins, starches, and other organic chemicals and polyphosphates, prevent crystal growth and stabilize a condition of supersaturation with respect to the content of calcium carbonate. The polyphosphates are most widely used, and their presence in the water in the amount of a few parts per million will prevent calcium carbonate scale.

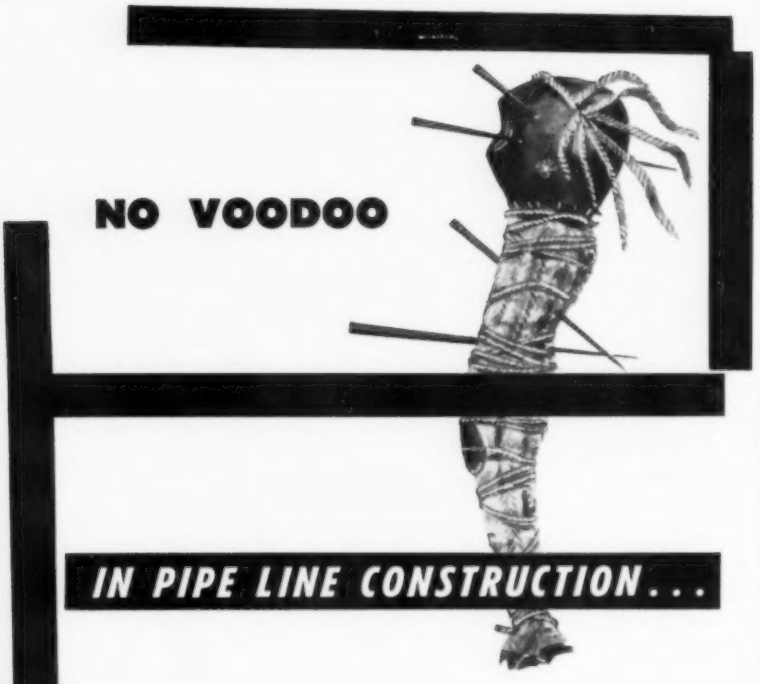
Corrosion Prevention

Controlled Carbonate Scale. As in scale prevention, the use of a controlled carbonate scale will prevent corrosion. Ideally, the scale is a thin crystalline deposit," of eggshell thickness, which permits only a minimum increase in the heat transfer rate.

Polyphosphates. Polyphosphates provide corrosion protection by establishing and maintaining a ferro-phosphate coating or film on the metal surfaces. Usually a higher concentration is required for corrosion than for scale protection.

This film is microscopically thin and does not interfere with heat transfer. It functions by shielding the metal from direct oxygen attack. Polyphosphates provide corrosion protection in the pH range from 5.0 to 10.0. The material gives a good measure of protection to aluminum, zinc, brass, bronze, copper, and steel surfaces. Because the film is not permanent, it requires replacement through the constant application of treatment.

Only this special category of polyphosphates has the ability to function this way as a surface active agent. Other phosphates, such as disodium phosphate used for boiler-water conditioning, cannot do the job. Polyphosphates are produced by a heating monosodium phosphate or disodium phosphate or mixtures of the two at



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elevated temperatures; when the water has been removed, two or more phosphorous atoms are joined together by means of oxygen.

There is a separate category of polyphosphates particularly well-suited for treating cooling-tower water systems. These materials have been modified to have slow dissolving characteristics. The treatment has a relatively constant rate of solution independent of the amount of water passing over it. Monthly water consumption figures determine the quantity of initial dosage, which can also be estimated from the rating of the system in tons of refrigeration or from pump circulation figures. Each month thereafter it is merely necessary to replenish the treatment, provided laboratory water analyses show the maintenance of a sufficient phosphate content at the original dosage.

This type of treatment is ideally suited for those installations where daily water analyses would be a problem. Maintenance time is low and control of dosage is automatic. Nor is there need for expensive equipment to provide for the constant rate of chemical feed.

Sodium Silicate. Sodium silicate forms a protective ferro-silicate film to prevent corrosion. Once the film is formed, the required dosage can be tapered down to four parts per million from the original eight parts per million. As chloride concentration increases, however, or as cooling waters become more concentrated, heavier dosages are required.

Sodium silicate is especially well suited for the treatment of relatively soft water or water containing moderate amounts of calcium and magnesium salts. High water hardness interferes with the formation of the film; here, it is good practice to combine polyphosphates with sodium silicate.

Alkalinity can be controlled by the type of sodium silicate used. Therefore, the alkalinity under certain circumstances could increase the pH and neutralize carbon dioxide. As with most corrosion inhibitors of this type, there must be sufficient dosage, otherwise the corrosive concentrates its attack at an unprotected portion of the metal.

Chromates. Chromates provide film protection by forming a closely adhering, microscopically-thin film on the metal surface. The treatment renders the metal passive to attack by depressing its solution potential. Both chromates and bichromates are most effective in the pH range from 7.0 to 9.5. Sodium bichromate requires the addition of caustic soda to attain this pH range. The caustic soda is not normally necessary with sodium chromate. If sufficient treatment concentration is not maintained, there is the possibility of localized action.

When chromates are used, dosages are normally regulated by matching the color of the circulating water with a color standard usually supplied by the water-treatment manufacturer. It is merely necessary to maintain the same or deeper shade of yellow in the circulating water as in the standard and a pH of approximately 8.5 to provide effective protection. In cooling towers, a minimum chromate concentration of about 200 to 400 ppm normally is recommended.

Deoxygenation. Another satisfactory way to eliminate corrosion is to remove oxygen, the primary corrosive agent, from the system. Vacuum de-aeration can do the job in cooling waters but the method is expensive. The use of sodium sulfite as an oxygen scavenger is not particularly applicable in cooling-water systems because its reaction with oxygen is slow in the relatively cold water. However, a catalyzed sodium sulfite is reported to overcome this drawback.

Combined Inhibitors. In actual practice corrosion inhibitors are combined for best results. Sometimes a synergistic action takes place that allows a lower resultant concentration to do the same job as a higher concentration of one of the individual materials. ★ ★

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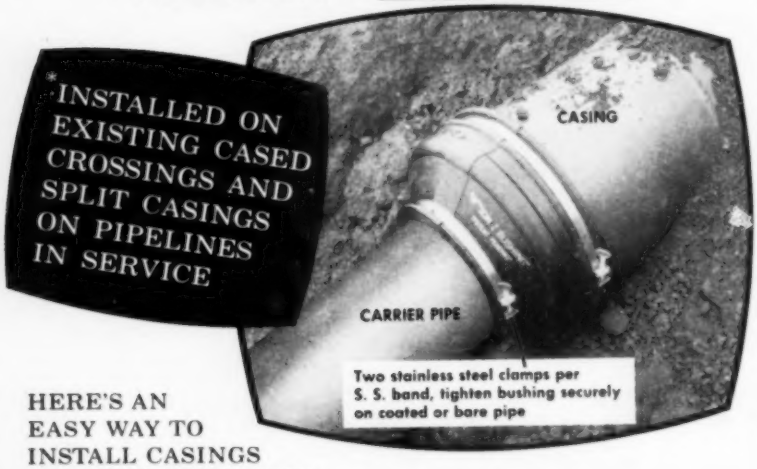
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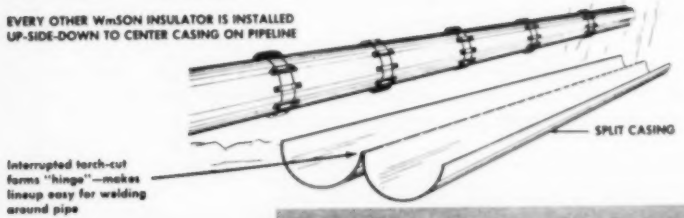
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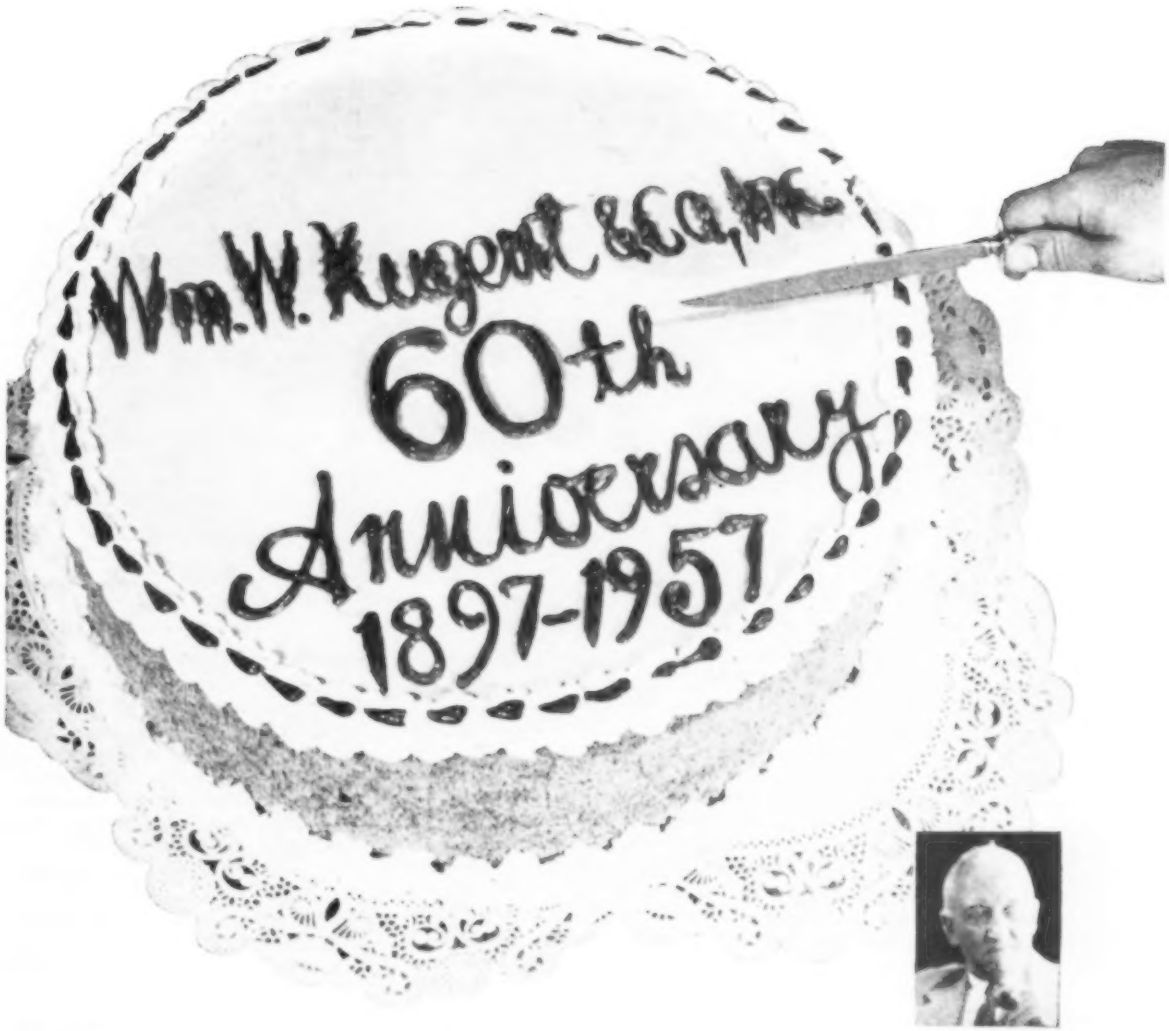

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Now, there are 18,500 miles of system and 683 stations being operated by U. S. pipeline companies

Microwave Mileage Grows in 1957

Dean Hale, *Technical Editor*

YOU don't have to travel far these days to find a microwave tower working for some pipeline company. In the past 12 months over 1700 microwave system miles and 80 stations were added, with another 2000 miles and 119 stations under construction at the present time, according to THE PIPELINE ENGINEER'S annual microwave survey.

It's an impressive list — over 18,500 miles of system and 683 stations, all operated by U.S. pipeline companies.

Even more impressive is the fact that increased use of channeling is being used on these circuits — anywhere from one to 85 channels per system. And the trend seems to be to greater number of channels, even on short systems.

In addition to the systems listed — either in operation or under construction — the survey revealed that there are some 2000 miles of microwave circuits and over 80 stations in the planning stages.

Under Construction

Union Oil Company, which placed in operation last year the first segment of its extensive system operating in the 2450-2700 mc band, is adding 17 stations and 597 circuit miles. Construction is underway on links between Los Angeles and Oleum, California. When completed, the system will "blanket" a large part of the company's facilities in California.

In the Rocky Mountain and great plains area, Colorado Interstate Gas Company is extending its system, with new links totaling 299 miles of circuits and 12 stations that will connect Larkin, Kansas, and Sanford, Texas, to its Colorado Springs headquarters.

Service Pipe Line has under construction a 160-mile, 7-station system between Freeman and LaPlata, Missouri, its second microwave system. Service also gained a 143-mile, 9-station system in West Texas when the company assumed operation of American Oil Pipe Line Company this year.

Texas Gas Transmission's long distance system — 700 miles and 33 stations between Owensboro, Kentucky, and Lake Charles, Louisiana — is in the final stages of installation and will be in operation this summer.

Shell Pipe Line Company has two systems under construction, a 120-mile, 6-station link between Cushing and Chelsea, Oklahoma, and a 93-mile, 5-station system between Roswell and Hobbs, New Mexico.

Atlantic Pipe Line Company is building a 162-mile, 6-station system to link Dallas with Temple and Esart, Texas, points.

Ohio Oil Company is adding to its new system a 150-mile, 7-station link from Martinsville to East St. Louis, Illinois.

Kansas-Nebraska Natural Gas Company has underway its first system, a 42-mile, 3-station link between Phillipsburg and Palco, Kansas.

Georgia Gas Company is building a 16-mile, 2-station system between Gainesville, Georgia, and a nearby compressor station.

And, in South Louisiana, Magnolia Petroleum Company is undertaking a "first" — a 76-mile, 5-station offshore microwave system linking its Morgan City offices to platform in Block 126.

Recent Additions

In the past 12 months, several large systems were completed and placed in operation. Biggest among these is the 760-mile, 29-station system between Ponca City, Oklahoma, and Houston, Texas, to be owned and operated jointly by Sinclair Pipe Line Company and Continental Pipe Line Company.

Ohio Oil Company has in operation its 322-mile, 17-station system between Findlay, Ohio, and Bridgeport, Illinois.

Richfield Oil Corporation completed its system, adding 220 miles of circuits and 12 stations.

Charleston Group Companies of Columbia Gas System have in operation their first system, a 97-mile, 4-station system, which includes one of the longest "hops" ever made. This hop extends 70 miles, between a station atop Fork Mountain (elevation: 3852 ft) and Dranesville, Virginia (elevation: 361 ft).

Other systems completed and in operation include Service Pipe Line, 90-mile, 4-station system between Bretch and El Reno, Oklahoma; Clinchfield Coal Corporation, 18-mile, 2-station system in Virginia; Sinclair Pipe Line, 90-mile, 5-station system extension in western Pennsylvania-eastern Ohio; Shell Oil Company, 18-mile, 2-station system between Brea and Long Beach, California, and Wilcox Trend Gathering System, a 20-mile extension on its system in Texas.

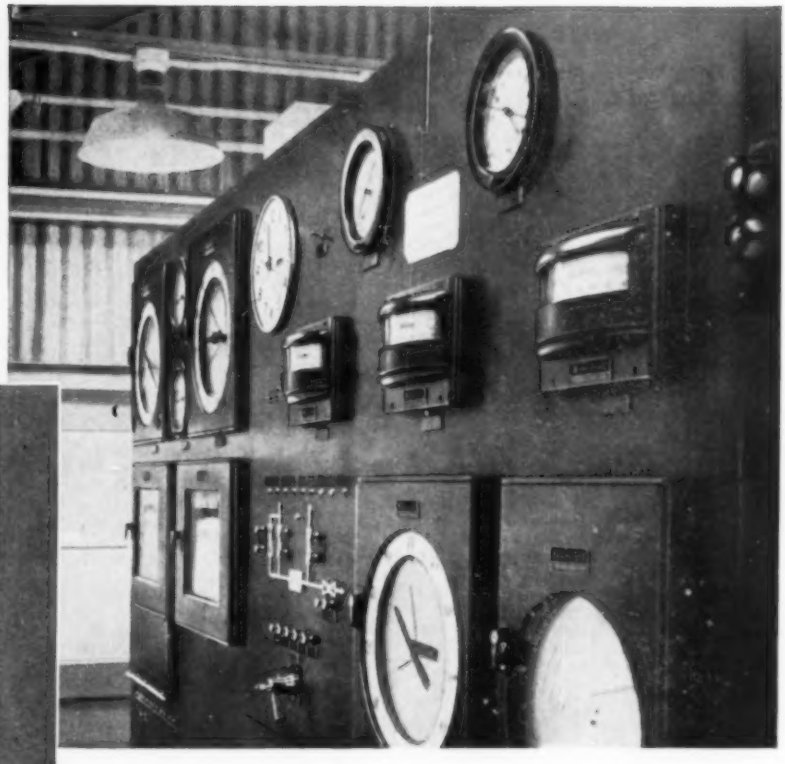
An up-to-date tabulation of U.S. pipeline microwave systems is presented in the following table. ⇒

PIPELINE MICROWAVE SYSTEMS
May, 1957

Here's where the more than 18,500 miles and 683 stations are located, according to the latest Pipeline Engineer Survey

Map No.	Name of Company Owning and/or Operating System	Date In Service	From	To	Length Miles	No. of Stations	Freq. Band	No. of Channels
1	Atlantic Pipe Line Co.	U. C.	Dallas, Tex.	Temple and Esart, Tex.	162	6	2000	13
2	Atlantic Seaboard Corporation	1957	Standardsville, Va.	Dranesville, Va.	97	4	2000	6
3	Buffalo Pipe Line Corporation	1954	Caledonia, N. Y.	Marrowlock Hill, N. Y.	19	2	900	1
40	Clinchfield Coal Corporation	1956	Osborne Gap, Va.	Dante, Va.	18	2	6700	3
4	Colorado Interstate Gas Co.	1954	Colorado Springs, Colo.	Keyes, Oklahoma	281	7	2000	3
4	Colorado Interstate Gas Co.	U. C.	Colorado Springs, Colo. Keyes, Okla.	Lakin, Kans. Sanford, Tex.	299	12	2000	28
41	Dow Chemical	1957	Thompsons, Tex.	LaWard, Tex.	79	4	6700	3
5	El Paso Natural Gas Company (San Juan System)	1952	Farmington, N. M.	Topock, Ariz.	450	11	6700	4
5	El Paso Natural Gas Company (Permian System)	1953	Midway, Tex.	Jal, N. M.	287	13	2000	21
5	El Paso Natural Gas Company (Western System)	1954	El Paso, Texas	Farmington, N. M.	478	12	2000	4
26	General Petroleum Corp.	1955	Santa Fe Springs, Calif.	Brea, Calif.	15	2	960	1
45	Georgia Gas Company	U. C.	Gainesville, Ga.	Compressor Station	15.5	2	2000	1
6	Humble Pipe Line Company	1953	Houston, Tex.	Kempner, Tex.	450	19	6700	3
7	Industrial Gas Supply Corp.	1955	Houston, Tex.	Alcomag, Tex.	20	2	6700	10
8	Interstate Petroleum Communications, Inc. (Shell P. L.)	1951	Cushing, Okla.	Elk City, Okla.	160	8	6700	3
8	Interstate Petroleum Communications, Inc.	1955	Wood River, Ill.	Maryland Hts, Ill.	22	2	6700	8
8	Interstate Petroleum Communications, Inc.	1953	Springfield, Mo.	Lawrence, Mo.	30	2	6700	4
9	Atlantic-Sinclair System	1949	Philadelphia, Pa.	Reading, Pa.	70	5	2000	6
9	Atlantic-Sinclair System	1954	Philadelphia, Pa.	Pittsburgh, Pa.	460	23	2000	9
42	Kansas-Nebraska Natural Gas Co.	U. C.	Paleo, Kans.	Phillipsburg, Kans.	42	3	6700	4
46	Magnolia Petroleum Corp.	U. C.	Morgan City, La.	Block 126 (Offshore)	76	5	2000	3
10	Michigan Wisconsin Pipe Line Co.	1954	Hansford, Tex.	Detroit, Mich.	1540	59	2000	6
11	Mid Valley Pipe Line Company	1950	Longview, Tex.	Lima, Ohio	1000	42	6700	10
12	Natural Gas Pipe Line Company of America	1953	Downers Grove, Ill.	Aurora, Ill.	20	2	6700	13
13	Natural Gas Storage Company of Illinois	1953	Herscher, Ill.	Cabery, Ill.	15	2	6700	2
14	New York State Natural Gas Corp.	1955	Syracuse, N. Y.	Utica, N. Y.	60	3	6700	2
15	Ohio Oil Company	1957	Findlay, Ohio	Bridgeport, Ill.	322	17	6700	24
15	Ohio Oil Company	U. C.	E. St. Louis, Ill.	Martinsville, Ill.	150	7	6700	5
16	Oklahoma Mississippi River Products Pipe Line (Sunray)	1952	Purcell, Okla.	Ada, Okla.	82	5	960	1
17	Oklahoma Natural Gas Company	1954	Muskogee, Okla.	Chickasha, Okla.	220	11	2000	15
18	Panhandle Eastern Pipe Line Co.	1952	Kansas City, Mo.	Tuscola, Ill.	400	18	6700	9
19	Plantation Pipe Line Company	1953	Bremen, Ga.	Athens, Tenn.	156	7	2000	13
20	Platte Pipe Line Company	1954	Casper, Wyo.	Wood River, Ill.	1007	44	6700	9
21	Richfield Oil Corporation	1953	Los Angeles, Calif.	Sulphur Mtn., Calif.	60	3	6700	2
21	Richfield Oil Corporation	1956	Saddle Peak, Calif.	Gorman, Calif.	220	12	2000	37
22	Salt Lake Pipe Line Company	1952	Salt Lake City, Utah		35	2	960	4
23	Service Pipe Line Company	1956	Bretch, Okla.	El Reno, Okla.	90	4	6700	5
23	Service Pipe Line Company	1951	Snyder, Tex.	Eldorado, Tex.	143	9	6700	7
23	Service Pipe Line Company	U. C.	Freeman, Mo.	LaPlata, Mo.	160	7	6700	10
43	Shell Oil Company	1957	Brea, Calif.	Long Beach, Calif.	18	2	6700	8
44	Shell Pipe Line Company	U. C.	Cushing, Okla.	Chelsea, Okla.	120	6	6700	22
44	Shell Pipe Line Company	U. C.	Roswell, N. M.	Hobbs, N. M.	93	5	6700	6
24	Sinclair-Continental System	1956	Ponca City, Okla.	Houston, Tex.	760	29	6700	85
25	Sinclair Pure System	1953	Cushing, Okla.	Independence, Kans.	190	9	6700	24
25	Sinclair Pure System	1953	Independence, Kans.	Salisbury, Mo.	260	13	6700	23
25	Sinclair Pure System	1953	East Pittsburgh, Pa.	McDonald, Pa.	20	2	6700	5
25	Sinclair Pure System	1954	Salisbury, Mo.	East Chicago, Ind.	475	21	2000	24
39	Sinclair Pipe Line Company	U. C.	Mazon, Ill. (station additions)	Four Spur Stations		(8 Terminals)	6700	—
39	Sinclair Pipe Line Company	U. C.	Quincy, Ill.	Mazon, Ill.	—	8	6700	—
39	Sinclair Pipe Line Company	1956	Clinton, Ohio	East Pittsburgh, Pa.	90	5	2000	5
27	Standard Oil Company of Indiana (Products Pipe Line Dept.)	1954	Morehead, Minn.	Mandan, N. D.	200	8	2000	4
28	Sun Pipe Line Company	1953	Hoffman, Tex.	Humble, Tex.	15	2	960	1
28	Sun Pipe Line Company	1955	Sour Lake, Tex.	Saratoga, Tex.	13	2	960	1
28	Sun Pipe Line Company	1955	Barbers Hill, Tex.	Liberty, Tex.	18	2	960	2
29	Tennessee Gas Transmission Co.	1955	Kinder, La.	Oakdale, La.	23	2	6700	2
30	Texas Company	1953	Salem, Ill.	Kaskaskia, Ill.	20	2	960	2
31	Texas Eastern Transmission Corp.	1954	Shreveport, La.	Linden, N. J.	1400	57	2000	8
32	Texas Gas Transmission Corp.	1950	Guthrie, La.	Sharon, La.	45	3	6700	5
32	Texas Gas Transmission Corp.	U. C.	Owensboro, Ky.	Lake Charles, La.	700	33	2000	—
33	Texas Illinois Natural Gas Pipe Line Company	1952	Houston, Tex.	Chicago, Ill.	1004	40	6700	9
34	Transcontinental Gas Pipe Line Corporation	1952	Falfurrias, Tex.	Linden, N. J.	1752	61	2000	11
35	Trunkline Gas Company	1954	Houston, Tex.	Tuscola, Ill.	1000	32	2000	8
36	United Gas	1953	Jackson, Miss.	Montpelier, La.	126	6	2000	8
37	Union Oil Company	1955	Torrey Hill, Calif.	Mulholland, Calif.	35	3	2000	4
37	Union Oil Company	U. C.	Los Angeles, Calif.	Oleum, Calif.	597	17	2000	49
38	Wilcox Trend Gathering System, Inc.	1954	Cuero, Tex.	Mineral, Tex.	62	4	6700	5
38	Wilcox Trend Gathering System, Inc.	1956	Mineral, Tex.	George West, Tex.	20	1	6700	3

This control panel at the Stanton satellite station permits fully automatic control—remote or local—including automatic alarm, startup, and shutdown.



At Gulf Interstate Gas Company's master control station, Nashville, Tenn., a section superintendent presses a button—shortly the satellite station at Stanton, 210 miles away, goes onstream, under full automatic control.

First satellite compressor station —completely automatic—

with HONEYWELL *instrumentation*

OPERATING completely unattended, Gulf Interstate Gas Company's satellite compressor station at Stanton, Ky., marks an important milestone in gas transmission.

The station has operated without a hitch since its completion early last year. Test results showed savings of 10 to 15% in operating costs . . . better control over line and delivery, especially during peak demand periods . . . dependability and safety, affirmed by FPC approval. This remarkable performance has encouraged Gulf Interstate to add four more satellite stations to its 1,160-mile system.

Much of the success of the satellite station is due to the fine degree of automatic control made possible by Honeywell instrumentation at the satellite and at the master control station at Nashville—210 miles distant. The satellite control system, designed for both local and remote automatic operation, includes Honeywell suction and discharge pressure controllers, and a completely automatic gas engine cooling tower control system.

Gulf Interstate's faith in Honeywell instrumentation has been borne out by the absolute reliability and accuracy so necessary in an unattended station.

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BROWN INSTRUMENTS

First in Controls

Hydrogen sulfide in the atmosphere created a problem in its Permian Basin operations ...here is what El Paso Natural did about..

Maintaining Microwave Equipment Under Corrosive Conditions

C. G. Fuller, Jr.
Communications Engineer
Permian Division
El Paso Natural Gas Company

COMMUNICATIONS departments of petroleum and natural gas companies are required to install and maintain microwave systems in locations and atmospheres that differ greatly from the usual communications systems.

Basic requirement of such a system is to provide communication service tying together the central administrative offices and the outlying plants and stations so that operations and maintenance can work more efficiently at a minimum of cost and time. This requirement necessitates, at times, a compromise in ideal conditions that communications engineers would like to have made available to them.

Ideally, equipment centers and repeater locations on microwave systems should have dust-free, corrosion-free, temperature and voltage controlled conditions. Cost considerations involved obviate some of these desirable conditions. So, communications departments must install and maintain equipment under conditions that are not controlled and further steps taken to keep the system "talking."

Corrosion From H_2S

Certain areas in which natural gas and petroleum are found contain corrosive gases in varying amounts. These unwanted gases are extracted from the natural products and, in the process, small quantities are released into the atmosphere. Thus, the equipment problem varies between locations in which the most corrosive gas, hydrogen sulfide, is very obvious to the nose, and locations where it is not noticeable.

Corrosion occurs to microwave equipment in all these areas in varying degree, and time is an important factor. In a highly concentrated area (which would mean only a few parts of H_2S per billion parts of air) corrosion is accelerated. If equipment is left unattended, and steps not taken to prevent and slow down the deterioration, a complete loss of communications and the investment involved would result.

As previously stated, the communications required involve locating the "drop repeater" stations as close as possible to the plant or office to be served. Normally, it is desirable to keep the baseband (carrier) frequency lines as short as possible and also keep telephone drop circuit distances to a minimum. This, then, necessitates placing the radio equipment near these areas of corrosion.

Repeater stations can be situated away from the actual operating area, but in large fields of petroleum deposits you are never far from the "oil patch" by reason of the very nature of the pipeline and producing companies' need to parallel their operating routes and locations with the communications system.

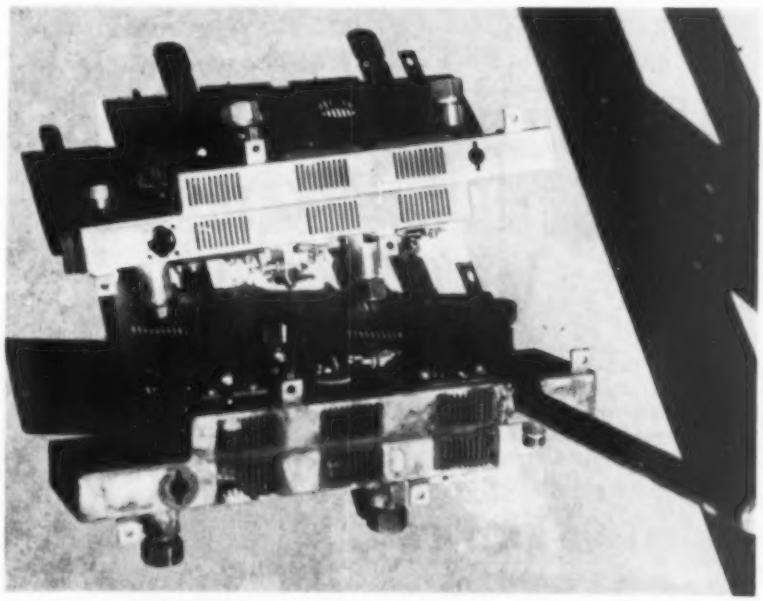
Corrosion exists universally in radio equipment. Ordinarily, it is not of sufficient concentration except to cause "tarnishing" of silver plated components over the years and probably the equipment will be retired long before actual deterioration results.

Eliminate Trouble at Source

Normal procedure in preventing and curing other types of troubles in the radio field is to eliminate the trouble at its source, or at least reduce the cause to a minimum. To the uninitiated, the obvious solution is to attempt to control the local atmosphere in the equipment building. To date, this has not succeeded.

Concentration of corrosion is so minute that normal methods of control, and, in fact, methods used to eliminate H_2S in the gas and oil produced cannot control these small quantities.

Methods used to detect the presence of H_2S in pipelines are insensitive in the atmosphere and filtering methods help



Two RF cavity assemblies — a new one and one that has become corroded due to exposure to hydrogen sulfide gas. Solution: Damaged equipment is thoroughly cleaned, then coated with rhodium.

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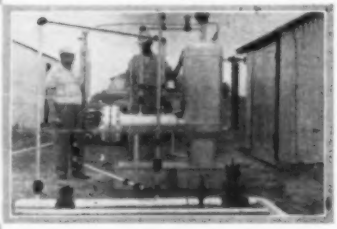

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merely to reduce but not eliminate the cause. Of course, one could air-condition and elaborately filter each equipment house, but the cost involved would be many times the cost of the radio equipment. Coaxial lines and antennae also are greatly affected and atmosphere control in this instance obviously would be impossible.

The greatest problem is created in the manufacture of the equipment. For years manufacturers have used silver and silver plated components throughout radio equipment. This is to provide a "corrosion-free conductor with a low resistance."

Silver does not fulfill the first condition except in desert atmospheres where there is nothing to corrode it. Throughout the entire United States and in many parts of the rest of the world people continually have to "polish" their silverware. This is corrosion to a smaller degree. Microwave equipment uses silver plated RF cavities, tubes, tube sockets, relay contacts, antenna fittings, telephone contacts, etc. In short, all radio equipment is subject to corrosion.

Silver, although the most susceptible, is not the only material used that corrodes. Copper is another common material used, due to its high conductivity, in telephone lines and in wiring of equipment. Normally, insulated wire that is tinned exhibits good non-corrosive characteristics. Lowly 50/50 or 60/40 solder is one of the best protectors. Occasionally a "cold-soldered joint" will result from improper soldering procedure, which allows the corrosion to enter the joint and cause a failure. By and large, however, it is the silver that causes most of the failures.

What El Paso Natural Does

After having determined the most susceptible material and the chief source of trouble, the following has been our procedure. Eliminate, when possible, the silver plated components, and when it is not possible to do so, provide protection.

Elimination means replacement of costly components (RF cavities) with new ones that have been plated with a metal of the platinum family, rhodium. This metal has excellent properties. Its conductivity and other characteristics compare favorably with silver, and its corrosion time is much greater than that of silver. Eventually, it also will "tarnish." The time involved is years, however, not months or weeks. Thus the major item in failures is greatly reduced.

One pitfall to be avoided is plating rhodium over silver. This combination will corrode almost as fast as silver alone.

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

What happens to pipe wrap underground?

Here's what a federal agency found out*. . .

Many wrap and enamel combinations were imbedded in a test tank filled with bentonite clay slurry. Extreme soil stresses were imposed on these samples by alternate wetting and drying cycles. Resistance to backfill puncture was also checked after each cycle. Holiday-detection tests showed that the glass fiber and coal-tar combination stood up through the full 25 cycles of the test.

*As reported in Journal American Water Works Association, Vol. 48, Feb., 1956. Photo courtesy U.S. Bureau Of Reclamation.

These impartial tests show why BLUE FLAG gives you complete pipeline protection

It was conclusively demonstrated that glass fiber mat like Blue Flag, with coal-tar enamel, provides effective protection against *both* soil-stress and backfill-puncture action. (See picture caption above for actual test conditions.)

This is the kind of protection you need for maximum service life. Yet it's yours for only ½ of 1% of initial pipeline cost when you use L·O·F Glass Fibers' Blue Flag.

No wonder glass fiber reinforcement like Blue Flag Pipe Wrap is preferred. It strengthens enamel . . . assures coating essentially free of holidays. And, Blue Flag helps speed application—its high tensile strength virtually eliminates breakage in the wrapping operation.

Yard-wrapped, or applied over-the-ditch, Blue Flag can be the answer to your pipeline protection problems. It's available from conveniently located distributor warehouses. For the address of the one nearest you, or for technical information, write: *L·O·F Glass Fibers Company, Dept. 72-37, 1810 Madison Avenue, Toledo 1, Ohio.*

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Recent aerial photograph of Standard Pipeprotection plant, showing increased facilities.

Each successive year more pipe passes through the St. Louis Gateway, where at Standard Pipeprotection it is coated and wrapped according to procedures that establish the highest standards of quality for pipe protection.

This increased traffic has necessitated the erection of extra pipe storage areas with greater capacity, additional railway sidings, new coating and wrapping machines, much larger parking areas, more roads for truck deliveries and enlarged office space.

The benefits you receive from SPI coated and wrapped pipe have resulted in more business for us.

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Protection is the next step. It is impracticable to plate tube socket contacts, relay contacts, etc. Having decided this, it was necessary for us to find some method of covering these contacts with a substance that would still conduct and yet provide a corrosion-inhibitant.

Television provided the answer. Television set maintenance men have long had the problem of maintaining good contacts in switches used in tuners in the RF stages of these receivers. Several manufacturers have developed inhibitors such as Walsco's "Tunerlub." This greaselike substance provided us with the necessary conduction and protection and is used on RF tubes (2C39's) and other tubes to slow down the process. It must be removed periodically to eliminate dust, which is a noise causer.

Maintenance procedures under these conditions come in for close scrutiny. Normally, technicians doing the maintenance work are required to visit a station only periodically, possibly once or twice a month. Under corrosive conditions it is necessary to make maintenance trips several times a week and in some cases daily. These inspections mean constantly checking and "wriggling" the tubes in their sockets to rub any corrosion off and insure good contact. Of course, this results in wearing out the tube socket contacts. Then the contact itself needs replacing.

The nature of the trouble found in tube socket corrosion usually is not a complete failure but rather a noise source, which is incompatible in a well maintained microwave system. Relay contacts follow much the same pattern.

The special case of RF coaxial cables and antennae requires a similar technique. Most difficulties can be elimi-

The Author

Charles G. Fuller Jr. is division communications engineer for El Paso Natural Gas Company at Jal, New Mexico. He joined the company as a radio technician in 1953.

Prior to joining El Paso Natural, Fuller operated his own TV business at Roswell, New Mexico, for one year, and prior to that served in the army for two years at Fort Bliss (near El Paso) on the guided missile program.

Before his army duty, Fuller worked as a communications technician for three years for Mobile Radio, Inc., at Minneapolis, Minnesota. Prior to that, he served as a communications technician for two years with Sanders Aviation Company in Washington, D. C.

He attended Benjamin Franklin University at Washington, D. C., for one year, majoring in accounting.

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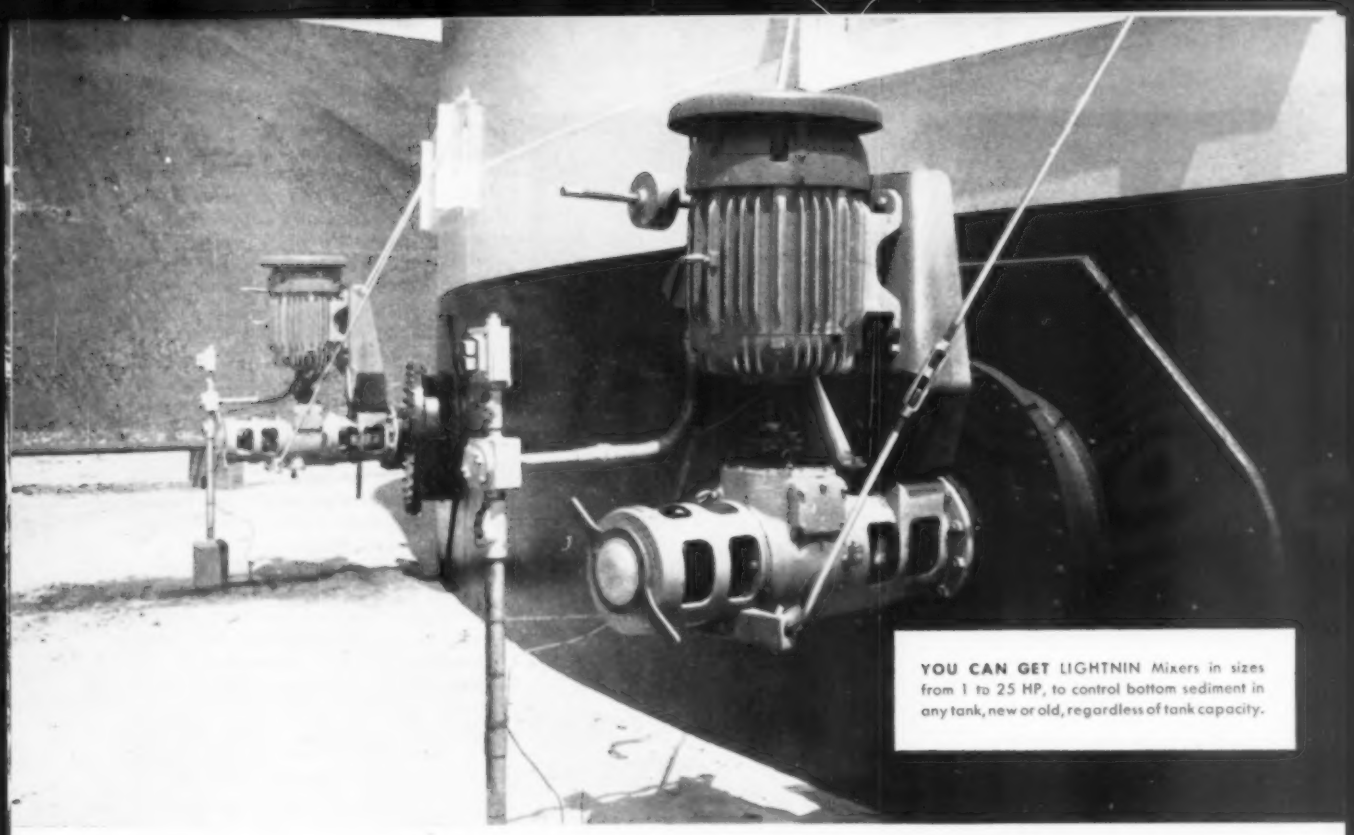

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How to store 10% more crude *without putting up another tank*

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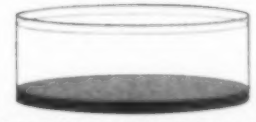
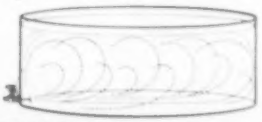


DO YOUR TANKS LOOK LIKE THIS? Settled sludge is probably costing you much more than you realize. Cleaning cost is only part of the story.



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Energetic Parts-Service on Truck Equipment — Tulsa Winches — Cleveland Trenchers and other Leland lines — is as close and as quick as your telephone. Call for a Leland man **today.**

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nated at the start by use of proper materials and methods during installation.

Air dielectric copper lines have been found to be entirely unsuitable. The theory of operation of copper lines requires installation of a line with the use of an inert gas under pressure. A recent failure was experienced on a line that had no observed loss in pressure over a three-year period. The failure was caused by corrosion of the inner conductor's connections throughout the entire length of a 200-ft run. Natural vibration caused a compression of the "bullets" used to connect the lengths of copper tubing. Addition of corrosion raised the resistance of the line to such a high degree that almost complete loss of signal was observed.

"Proper materials" referred to above means use of a cable that utilizes only two connections — one at the antenna and one at the transmitter end. Thus, trouble spots are eliminated at the start. When properly installed, this cable is sealed at each end and needs only a wrapping of sealing tape over the connectors to the antenna and the bottom end. Corrosion is thus prevented for many years of service.

Telephones and their respective lines require a somewhat different approach. The telephone set itself is relatively free of silver and its companion, corrosion. Most susceptible component is the hook switch. Application of "Tunerlub" periodically and regular cleaning give long periods of troublefree operation.

Telephone lines themselves are a problem that has no simple solution. Constant maintenance is required, which involves periodical cleaning of connections by scraping the conductor to renew the joint. This results in reduction of the overall size of the wire and after a long period of time necessitates replacement. Copper is somewhat slow to deteriorate and maintaining it is easier than silver.

Thus, the problems encountered in maintaining microwave radio and associated equipment are increased in hydrogen sulfide areas just as they are in jungle-type high-humidity areas, and only a close scrutiny of each problem as it arises is needed to reduce the trouble to an extent that normal operations can be maintained.

Use of full-standby equipment has not been tried in this instance as it was felt it would only add more equipment to corrode.

Under these conditions, systems are operating and maintaining availability results in excess of 97 and 98 percent.

Constant maintenance and prevention are the answers to maintaining radio equipment under corrosive conditions. ★ ★ ★

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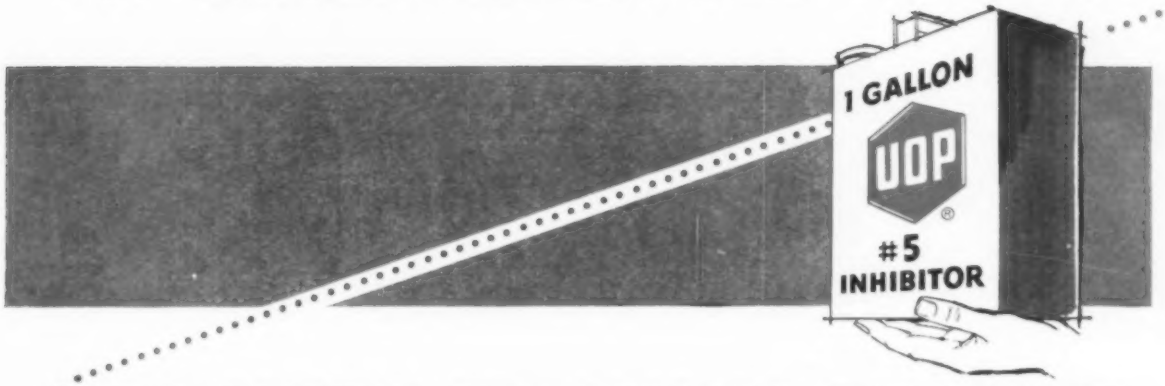
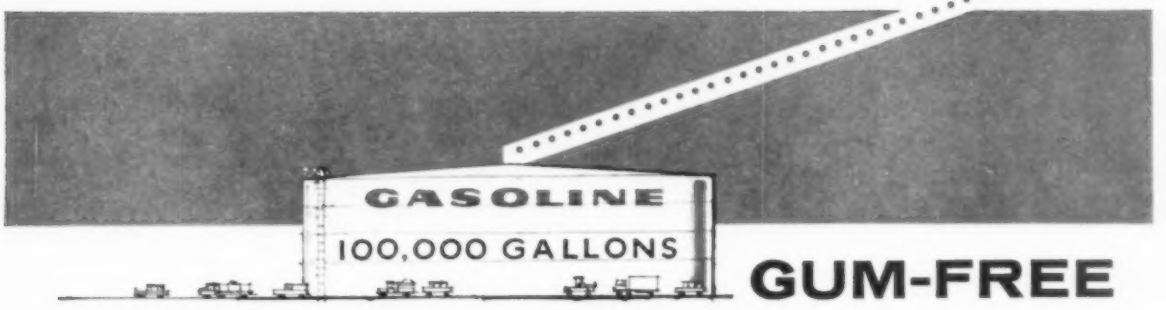


* TO KEEP SO MUCH OF THIS



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UOP #5 is one of a number of UOP inhibitors and additives available to the refining industry. If you have a protection or preservation problem for product or transport facilities consult us.

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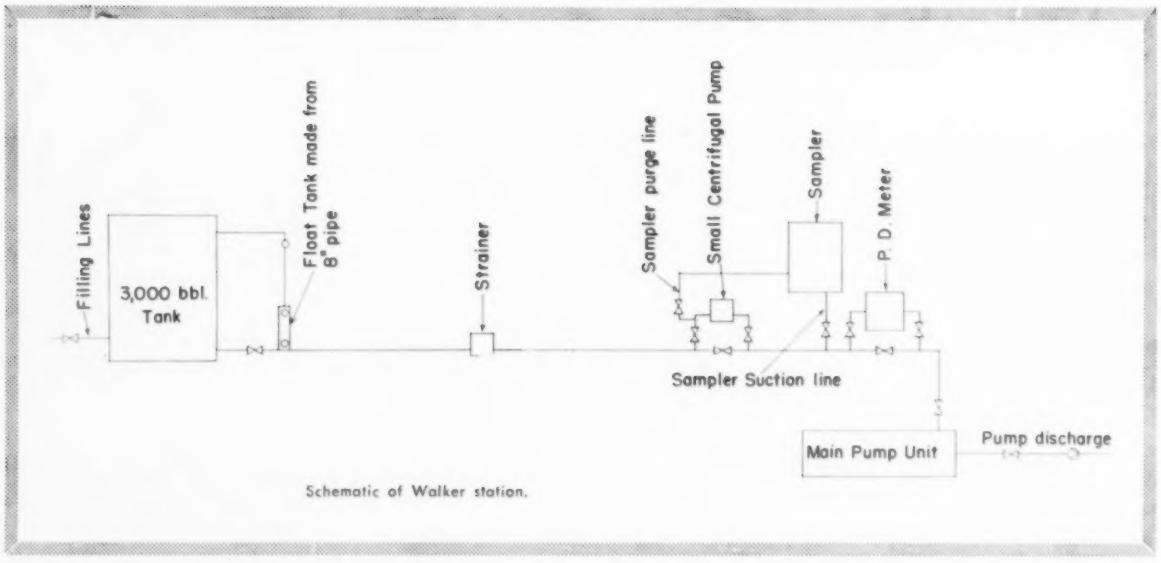


Schematic of Walker station.

Sohio Pipe Line and Ohio Oil Company Have Successfully Accomplished

Custody Transfer with Positive Displacement Meters

James F. Morris
Engineer, Pipe Line Department
The Ohio Oil Company

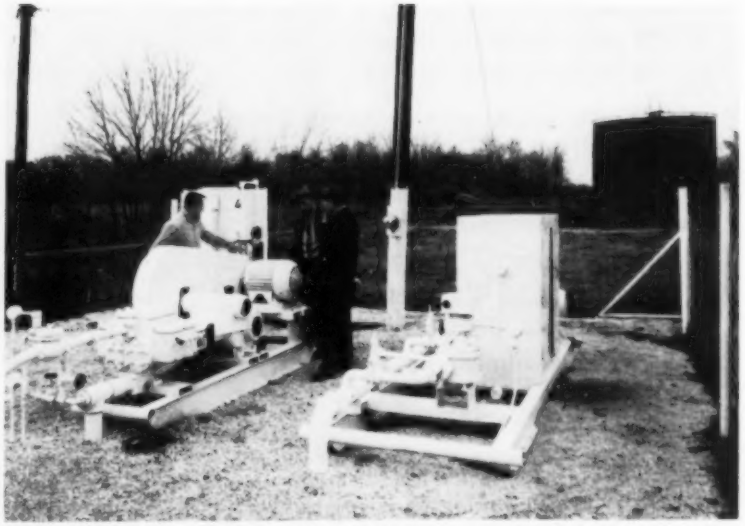
THE Ohio Oil Company, on June 13, 1956, began receiving oil from the Sohio Pipe Line Company through a positive displacement meter. This installation at the Walker station near Patoka, Illinois, is one of the first of its kind in the country.

Four significant facts highlight the operation:

- **Custody transfer takes place with neither party present.**
- **A positive displacement meter is used to accomplish this transfer.**
- **The meter is proved with an ordinary 3000-bbl field tank.**
- **Economy — equipment and installation cost less than $4000, and minimum maintenance is required.**

Equipment

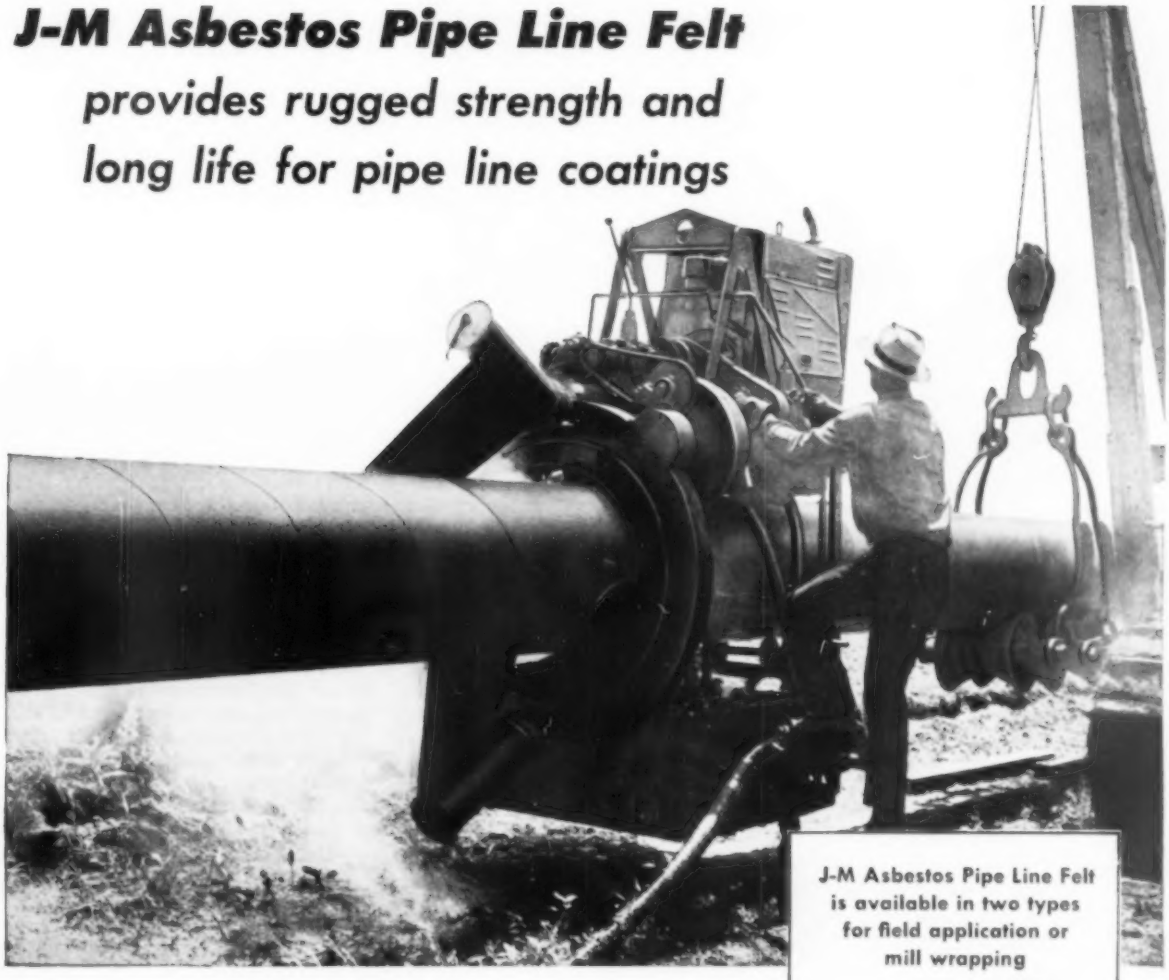
Equipment for Walker station was selected with an eye to simplicity and, therefore, kept to a minimum. The basis of this station, of course, is the



View of entire equipment outlay at Walker station; 3000-bbl prover tank in background.
Photos by Clarence Keller. Courtesy The Ohio Oil Company.

J-M Asbestos Pipe Line Felt

provides rugged strength and long life for pipe line coatings



Permits high-speed wrapping and effective protection for enamels

Johns-Manville Asbestos Felt gives pipe line coatings the rugged strength that is needed to guard the enamel from years of soil action. It forms a *stable* coating to reduce the hazards of pipe line corrosion leaks and provides a sound foundation when cathodic protection is used. Inorganic asbestos felt is the only wrapper that has survived more than half a century of actual service conditions in all types of soils.

J-M Asbestos Pipe Line Felt acts as a continuous sheath over the enamel . . . guarding the coating from the effect of the shifting grip of the soil as it expands and contracts due to alternate wetting and drying. It resists the destructive action of bacteria, fungi and soil chemicals, thus assuring long life to pipe line coatings.

J-M Asbestos Pipe Line Felt is available in two types for field application or mill wrapping

Transhield® Asbestos Pipe Line Felt—for average soil conditions.

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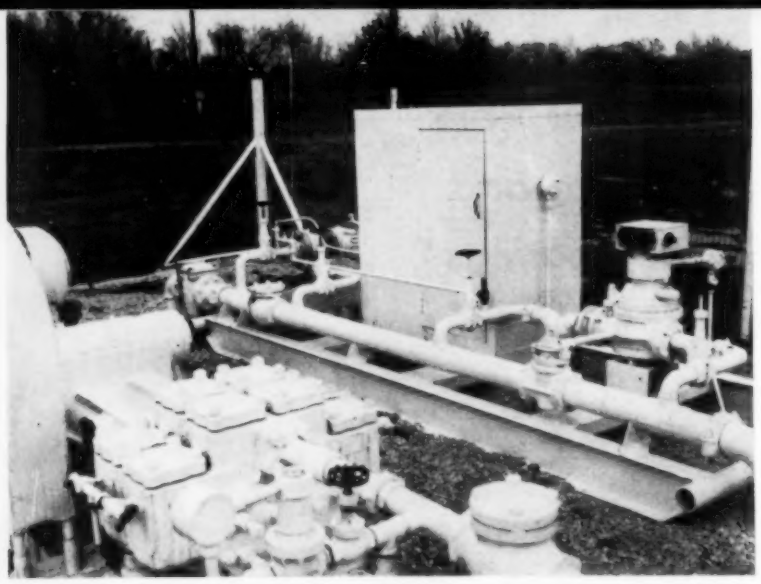
For further information about Johns-Manville Products for Pipe Line Protection, write to Johns-Manville, Box 14, New York 16, N. Y., in Canada, Port Credit, Ontario.

Johns-Manville **ASBESTOS FELT FOR PIPE LINE PROTECTION**



Skid-mounted pump, sampler, and meter. Main pumping unit in foreground.

meter. The meter, equipped with temperature compensator, is mounted on a skid along with a 2 by 2 single-stage centrifugal pump driven by a 3-hp motor, and a sampler.

On a dual skid is mounted a duplex positive displacement pump driven by a 10-hp motor.

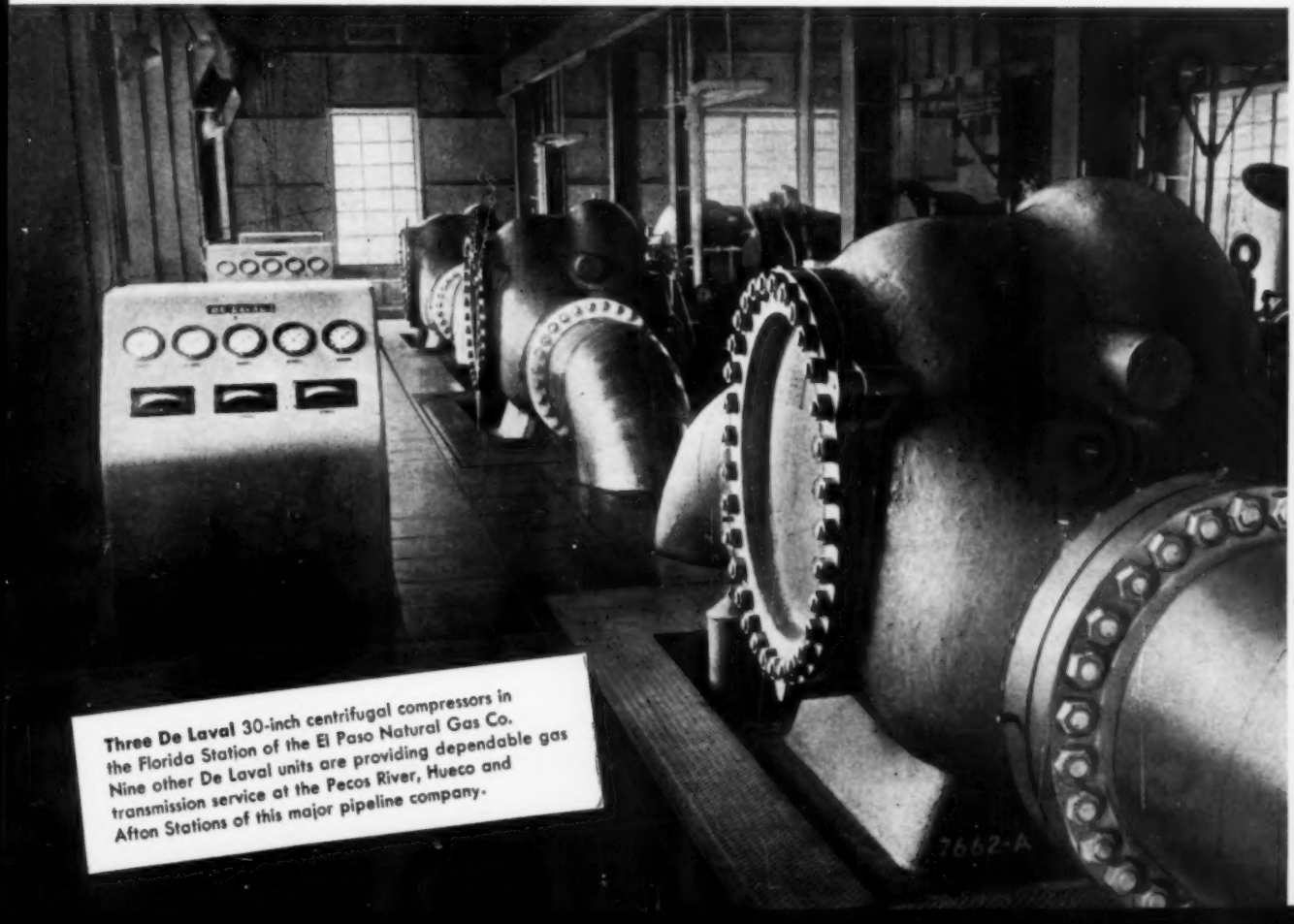
Perhaps the most striking thing about Walker station is the absence of a formal prover tank as such. The station utilizes an ordinary 3000-bbl field tank as a prover.

At times, the main pump at this installation is required to buck a line pressure of 200 psi. This situation, along with the fact that the main pump was to be a positive displacement type, led to the possibility of surges occurring on the meter. There was also the possibility that the meter might at some time has a vacuum upon it.

For these and other reasons, it was decided to place the centrifugal pump on the suction side of the meter. This assured that the meter would have pressure upon it at all times. The centrifugal pump also greatly reduced the possibility of surging the meter. There was some question as to whether line conditions would cause the meter any trouble, but, because this was one of the first installations of its kind, it was decided to play safe and install the pump.

The choice of the centrifugal pump and its placement on the suction side of the meter allowed one more thing to be done that possibly justifies the use of this type pump in similar installations.

One of the biggest problems in positive displacement meters is that of air. This station was equipped with a high and low discharge pressure shut down on the main pump. A low discharge pressure shut down also was placed on the discharge side of the small centrifugal pump. Thus, the minute any air might hit the pump, the pump would lose its discharge pressure, as is the nature of centrifugal pumps. This would shut the station down, of course, and protect the meter from air. The meter is protected from air by the float switches on the tank, but the pump shutdown arrangement provides another safeguard.



Three De Laval 30-inch centrifugal compressors in the Florida Station of the El Paso Natural Gas Co. Nine other De Laval units are providing dependable gas transmission service at the Pecos River, Hueco and Afton Stations of this major pipeline company.

Frank Hetzler, the author, and J. M. Joyce discuss the small centrifugal pump, placed on suction side of meter to minimize surging.

J. M. Joyce, Ohio's station engineer, removes sample can from sampler.

The sampler takes its sample from the discharge of the centrifugal pump, purges itself back into the suction side of the pump (see sketch) then deposits the sample into a container. The suction to the sampler originates in the center of the line being sampled by means of a tube placed horizontally through the line with a 3/32-in. slot in it. This arrangement is designed to give a representative sample across the line.

The device samples on a timed interval. At present a sample is taken every 30 seconds. The rate of sampling can be regulated to fit any sampling condition so far as quantities are concerned.

Proving the Meter

Proving of the meter is a relatively simple operation. Normally, this is done once a month with both companies participating. As the 3000-bbl field tank is used as a prover tank, it is possible to run considerable oil during the proof. This possibility is capitalized on and usually the proof consists of running some 1500 to 1600 bbl through the meter.

In strict accordance with the API code, the gager takes the temperature of the tank with a standard approved cup case thermometer. He reads the temperature of the tank to the nearest degree and estimates to the nearest 1/10 of a degree, then interpolates the correction factor accordingly. In order to obtain as accurate a gage as possible, a special tape, graduated in 32nd's, is used, a "C" clamp is employed, and an outage gage is obtained.

With care this arrangement allows the gager consistently to cut the tape

DE LAVAL

CENTRIFUGAL COMPRESSORS

on the job at El Paso Natural Gas

De Laval centrifugal compressors offer many important engineering features. (1) They are designed to handle an increased ultimate flow, can be quickly converted to larger capacities by replacing the impeller, diaphragm and a few minor parts. (2) The high pressure shaft seal eliminates leakage, consumption of sealing oil is negligible. (3) There is only one moving part—the rotor—which has ample clearance. (4) Units are compact, require smaller foundations and smaller stations. (5) First costs and installation costs are low.

Bulletin 503 gives data on De Laval Centrifugal Compressors. Write for your copy.

DE LAVAL *Centrifugal Compressors*

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DL375

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With a 16-Year Record!

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To reduce maintenance costs on distribution lines, you need the best possible protection you can get at lowest possible cost. Since 1941, TAPECOAT has led the way in providing dependable, low-cost preventive maintenance on gas lines in underground service.

Today, the performance of this original coal tar coating in handy tape form is more important than ever in your maintenance picture. Equal in effectiveness to mill coating on the pipe, TAPECOAT gives your lines the continuing protection of coal tar. It can be applied *positively* because it has its own perfect bond. No skilled help is required because it is simple to spiral-wrap with the use of a torch. And once TAPECOAT is on, you know from its 16-year record that it will give you uninterrupted protection.

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Originators of Coal Tar Coating in Tape Form

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D-72

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Jim Kindrick of Sohio employs a "C" clamp and special tape to gage the prover tank to nearest 1/32 of an inch.

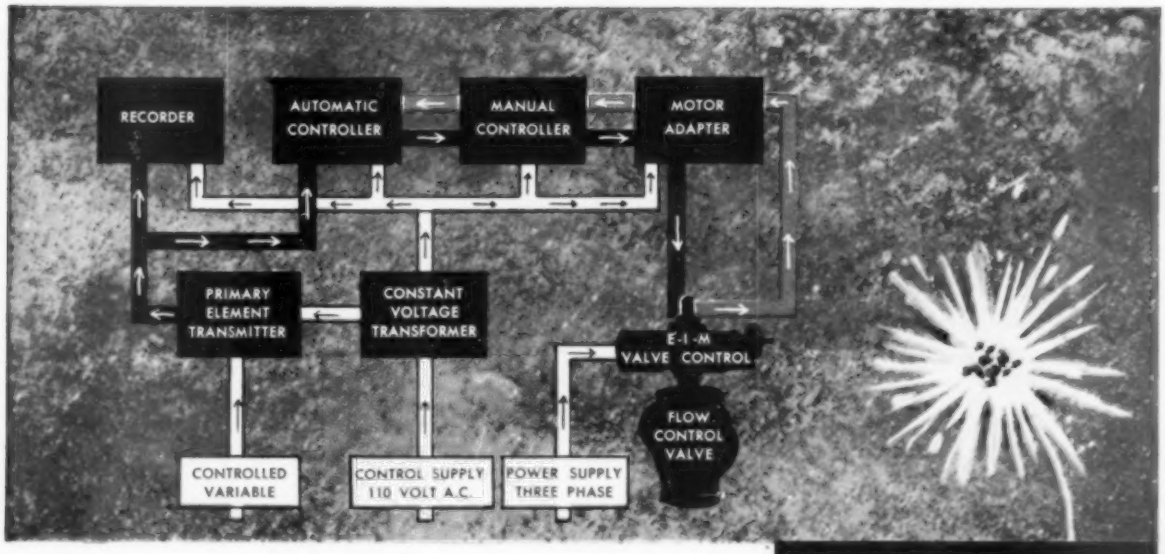
to the nearest 32nd of an inch. The tank tables are interpolated accordingly. Once the tank is on line, it is pumped to shut down. This operation usually is accomplished overnight. The following morning the tank is regaged and, with a meter reading, the meter factor is computed.

Operation

Sohio's ownership in this station ends with the valve on the 3000-bbl tank. The Ohio Oil Company owns the installation from this point. Immediately outside the tank there is a ⅛-in. piece of pipe (see sketch) in which are mounted the high and low level float switches.

These float switches are arranged so that the tank fills to 7 ft 6 in., whereupon the top float switch is actuated and the tank is pumped down. A third float switch near the top of the tank triggers a warning device should the tank fill to this level. This float switch arrangement has many advantages:

- Sohio's gager may fill the tank at any time he chooses (even while the meter installation is running) because the oil still belongs to him until it passes the meter.
- The use of two switches for a high and low run keeps the installation from running intermittently should the tank filling rate approach the pump rate when the tank is at the low shut-down level.
- The switch at the top of the tank eliminates the possibility of running the



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For complete details of the FUTRONIC valve control write

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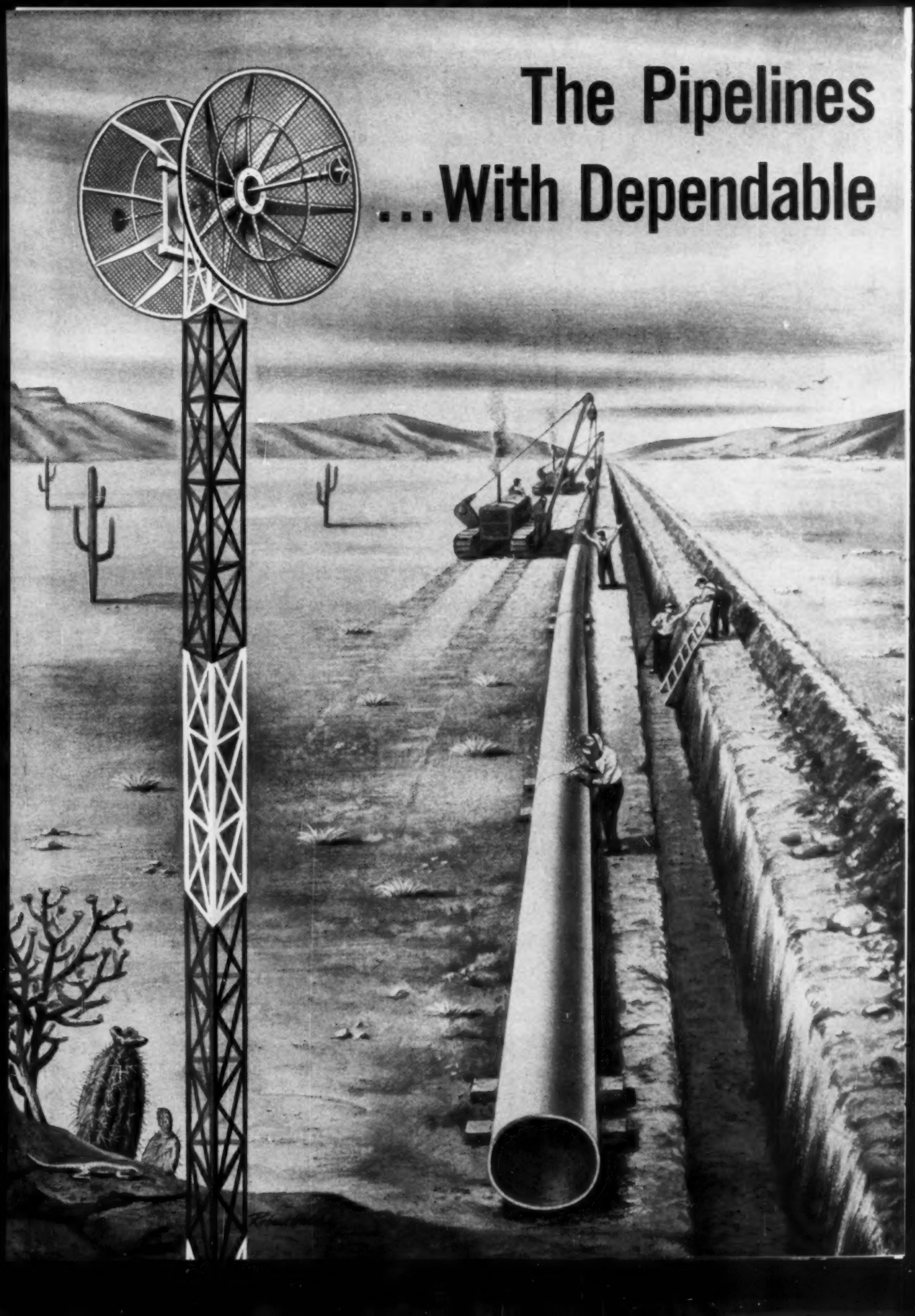
The Pipelines
...With Dependable

Look to Remote Control RCA MICROWAVE RADIO

A giant industry . . . already transporting trillions of feet of gas, billions of gallons of crude oil and products, in hundreds of miles of underground pipeline . . . is expanding its facilities to double . . . triple . . . quadruple its capacity! As the pipelines grow, they count on microwave radio relay to control operations. Today, the pipelines are the biggest private users of microwave.

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IN UTILITIES—In the comparably great utility industry expansion, RCA Microwave Radio is providing vital communication functions, including voice, teletype, telemetering, supervisory control, load control, facsimile, remote control. High-speed tone usage also can be provided.

IN OFF-SHORE DRILLING—Microwave radio relay systems are now being installed in off-shore operations to provide communications for coordinating production and pipeline operations. Microwave has been selected because of crowded VHF radio conditions and because it easily provides facilities for such additional services as telemetering and equipment control.

COMPLETE SYSTEMS—including erection of towers, equipment housing, emergency power and construction of desired facilities—will be installed under supervision of specially trained engineers; can include circuits for mobile radio control. Nationwide services of RCA Service Company are provided to keep your system operating at its peak.

ON TURNPIKES—On the new superhighways RCA Microwave Radio provides dependable circuits for voice, facsimile, teletype, VHF control, traffic and business machine communications, giving operating personnel complete control, assuring greater road safety and service for patrons.

IN COMMON CARRIERS, AND AT WATERWORKS—The reliability and economy of RCA Microwave Radio make it ideal for telephone company applications. It is also gaining increased application as a communications medium for transmitting water level data to out-of-town water plants.

RCA MICROWAVE RADIO offers the most advanced engineering features. Techniques standardized and proved in 1700 to 2700 mc portion of spectrum; maintenance simplified by use of highly perfected UHF triode tubes, non-regulated power supplies; ease of field tuning through use of straight forward circuits and standard equipment units that are easily maintained. Single sideband frequency division multiplexing conserves frequency spectrum and gives assurance against obsolescence. Only two frequencies required. Provision for easy addition of future channels makes RCA Microwave the least expensive form of communications per channel mile.

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THE MERCOID CORPORATION
4211 Belmont Ave., Chicago 41, Ill.

tank over should the filling rate exceed the meter pumping rate for any extended length of time. This switch presently lights a light in a pump station about six miles distance from Walker.

In addition to the high tank float switch arrangement, Walker station is equipped with three other safety devices. The main pump, as previously mentioned, is equipped with both high discharge and low suction shut-down pressure switches. The telemetering equipment, which transmits the meter readings remotely to a nearby main line pumping station, also acts as a safety device in that it allows the main line engineers to observe when the station is in operation. The entire installation is exposed to the weather, which eliminates the possibility of dangerous fume accumulation.

The Walker station operation actually requires that a man be present only once a week. Each Monday morning Ohio's representative and Sohio's gager meet and read the meter. They make a ticket for the transfer of oil of the previous week. The sample can is opened and the sample ground by the conventional API approved method. The ticket is then forwarded to the main offices. Here the proper meter factor is applied to the meter reading. The meter factor is obtained by proving the meter, an operation that presently takes place once a month.

Walker station is designed for low maintenance cost. The entire equipment area is fence-enclosed and covered with white rock. Normal pump, motor, and valve maintenance is necessary, but to date the meter has required no maintenance whatsoever. A second meter is kept in readiness in event the installed meter should fail to function. This standby meter can be installed in a matter of a few hours.

Future

Ohio Oil and Sohio both are accumulating information obtained at Walker and evaluating it in terms of future installations. Probably the next step or addition to this station will be a BS&W monitor. There will be continuing effort on the part of both parties to improve sampling techniques and equipment. ★ ★ ★

LAUGH WITH BARNEY

A fellow who was asked if he believed in heredity said, "I certainly do. Look at my two-year-old boy trying to put his toe in his mouth. He inherits that from my constant struggle to make ends meet."

"OVER 2500 FEET OF LOW COST DITCHING IN LESS THAN 5 HOURS"

"I use my 4T Pow-R-Ditcher for foundation cuttings and footings. Also install water lines. Used it to cut 2500 feet of ditch in less than 5 hours for Phillips Oil Co. It is small, rugged, very maneuverable and does a superior digging job even in sticky gumbo soil. Very easy to transport from one job to another in a pickup truck."

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ONLY 48" WIDE, 6' HIGH, 13' LONG
An ideal machine for laying gas pipe, service lines and digging home foundation footings. This rugged "Midget Ditcher" digs 6" to 14" wide and down to 4½' deep. Thousands in use. Same size moving parts as larger Pow-R-Ditcher Models. Write for complete information on the complete Pow-R-Ditcher line.

Some Excellent Sales Territory Available

VERMEER MFG. CO., 1443 W. Washington, Pella, Iowa

Wax coating and plastic wrapper were applied by a conventional traveling-type machine.

Closeup of plastic wrapper going on pipe.

After Four Years . . .

Wax-Coated-Plastic Wrapped Pipe Good as Ever

In Indiana, tests show that you can give even old pipe a decent burial

Kay Jones,
Chief Engineer
Indiana Farm Bureau Cooperative Association, Inc.

IF you don't give a pipeline a decent burial, it may keep coming back to haunt you in later years. Even the ancient Egyptians were meticulous in wrapping their mummies, and today's pipeliners must be just as choosy in determining pipe protection.

Planning a new products pipeline in early 1952, the Indiana Farm Bureau Cooperative Association, Inc., was confronted with the problem of selecting a pipe coating and wrapper that:

1. **Could be applied during winter months,**
2. **Could be applied to reconditioned pipe without difficulty,**
3. **Would be relatively inexpensive, and**
4. **Would provide maximum underground protection.**

To solve the problem, a microcrystalline wax coating combined with a polyvinylidene (pronounced poly-vanilladeen) chloride plastic wrapper was selected. The line was "kicked off" in October 1952. Despite some very adverse weather conditions, no difficulty was encountered during application of the wax coating and plastic wrapper. After over four years, the line is still excellently protected.

Old Pipe Used in New Line

Pipe for the line was reconditioned 8-in. line pipe, which originally had been used in a line in western Illinois and was later taken up. This pipe was brought to a central yard, where it was straightened. Old unsatisfactory welds and pits were cut out, and the pipe was rewelded in the yard.

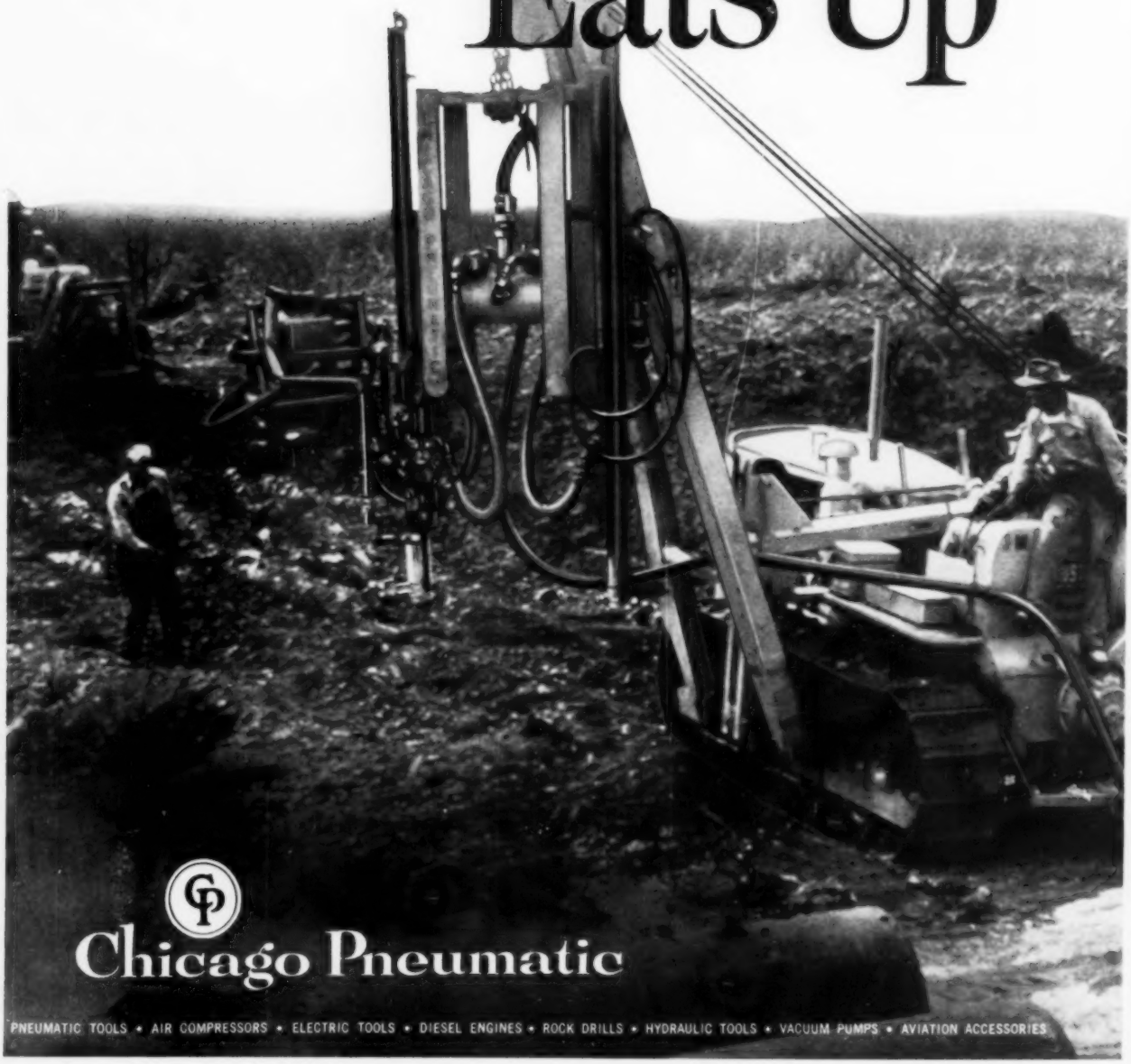
Pipe was then strung, welded, cleaned with a conventional cleaning

TABLE 1. Typical Physical Property Specifications.

Melting point (ASTM D127-49)		165–175 F
Viscosity, SSU @210 F (ASTM D88-44)		75–100
Penetration, needle 100 gms, 5 sec, 77 F (ASTM D5-49)		28–32
Ash (ASTM D482-41)		0.1–0.3
Specific gravity @32 F		0.947
(ASTM D70-27)	@ 77 F	0.928
ASTM 287–39)	@170 F	0.816
	@250 F	0.789
Flash point (ASTM D92-45)		525 F min
Fire point (ASTM D92-45)		550 F min
Inhibitors		Selected
Wetting agents		Selected

CP "Power Vane" Rotary Compressors are available in capacities of 125, 210, 365, 600 and 900 cfm.

"Eats Up"



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Team up the dependable CP "Power Vane" Rotary Compressor with the GTD-300 Trenchdril. Add your own side boom tractor and you've got a combination that's really great when the going gets tough! For more details call your nearby CP equipment dealer or write direct to *Chicago Pneumatic Tool Company, 8 East 44th Street, New York 17, N. Y.*

Tough Sections

. . . and comes back for more!

machine, coated and wrapped with a conventional traveling machine, and lowered directly into the ditch. The accompanying photos illustrate application of the wax coating and plastic wrapper. Pitted condition of the pipe is easily visible through the wax coating. The line was not inspected or jeeped with a holiday detector.

Construction started at Mount Vernon, Indiana. Excellent weather conditions prevailed for the first 40 miles of construction. The next 40 or so miles into the Switz City terminal was coated and wrapped under very adverse conditions caused by much rain, snow, freezing, and thawing weather. Despite these adverse conditions, an excellent coating and wrapping job was obtained as indicated by the high pipe-to-soil potentials shown in Table 4 with a minimum current output from the rectifiers.

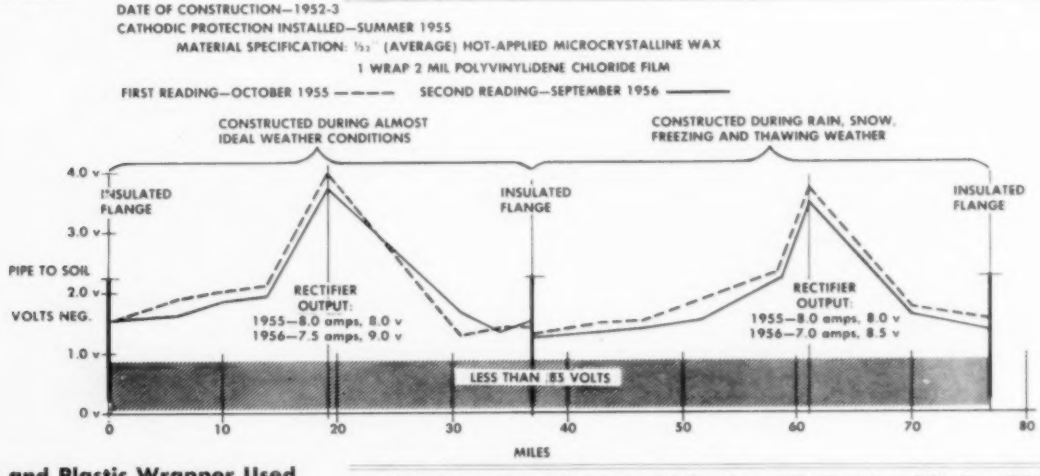
A wide variety of terrain is traversed by the pipeline, from rugged hills to flat river bottom land. Soil type varies from dense clay and sandy clay in the hills to muck and sandy loam in the river bottoms.

TABLE 2. Properties of Polyvinylidene Chloride Film.

Gage in inches	0.002
Specific Gravity	1.68
Area factor, approx sq in./lb	8150
Water vapor transmission gms/100 sq in./24 hr at 100 F and 90% R. H	0.20
Water absorption	Negligible
Resistance to heat — intermittent	Up to 200 F
Resistance to heat — continuous	Up to 140 F
Resistance to cold	Good flexibility at 0 F
Tensile strength psi	7000–15000
Percent elongation	20–40
Bursting strength psi — Mullen	60
Tear strength — gms — Elmendorf	30–40
Dielectric Constant	
10^2 cycles	4.9–5.3
10^3 cycles	3.9–4.5
10^5 cycles	3.4–4.0
Percent Power Factor	
10^2 cycles	3.5–4.5
10^3 cycles	5.2–6.3
10^5 cycles	3.9–4.5
Breakdown voltage, volts/Mil	3000–4500
Surface resistivity, ohms	10^{12}–10^{15}
Volume resistivity, ohms — cms	10^{12}–10^{15}

TABLE 3. Chemical Resistance of Polyvinylidene Chloride Films at 25 C.

Dilute mineral acids	Excellent
Concentrated mineral acid (except H_2SO_4 and HNO_3)	Excellent
Organic acids	Excellent
Alkalies (except NH_4OH)	Good
Alcohols	Excellent
Aliphatic Hydrocarbons	Excellent
Oils, fats and waxes	Excellent
Pharmaceuticals and detergents	Excellent



Wax and Plastic Wrapper Used

High quality microcrystalline wax coating was first applied to the pipe surface and then spirally wrapped with a 2-mil polyvinylidene chloride plastic wrapper. The reconditioned pipe surface was mechanically cleaned with a conventional brush and knife cleaning head prior to application of the microcrystalline wax coating. No primer was used. No over-wrap was used over the plastic film.

Table 1 tabulates typical physical properties of the microcrystalline wax coating.

What the Wax Is . . .

Microcrystalline wax is a complex mixture of normal paraffinic, isoparaffinic, and naphthenic solid hydrocarbons. They are long chain molecules

TABLE 4. Pipe-to-Soil Potential Readings, Mile Post 0 to Mile Post 76.9.

Mile post location	P/S Readings—volts required		Rectifier output		
	Oct. 1955	Sept. 1956	Oct. 1955	Sept. 1956	Remarks
0.0	1.61	1.60	...	...	Insulated flange
1.1	1.60	1.58	...	...	...
6.5	1.94	1.75	...	...	...
10.0	2.06	1.88	...	...	...
14.0	2.15	1.99	...	...	...
19.5	4.00	3.80	8.0 Volt 8.0 Amp	9.0 Volt 7.5 Amp	22 Volt—25 Amp rectifier
30.9	1.31	1.70	...	...	...
34.1	1.43	1.39	...	...	...
37.0	1.45 (South) 1.30 (North)	1.57 (South) 1.26 (North)	...	...	Insulated flange
42.8	1.50	1.38	...	...	...
46.5	1.54	1.41	...	...	...
51.8	1.90	1.56	...	...	...
58.6	2.35	2.20	...	...	...
61.2	3.70	3.50	8.0 Volt 8.0 Amp	8.5 Volt 7.0 Amp	22 Volt—25 Amp rectifier
70.0	1.75	1.64	...	...	...
76.9	1.60 (South) 1.27 (North)	1.38 (South) 1.29 (North)	...	...	Insulated flange

TABLE 5. Coating Resistance Tests.

WHERE: 8-inch products pipeline
AGE: Approximately 4½ years.
COATING: Microcrystalline wax and polyvinylidene chloride wrapper
ENERGIZING SOURCE: Rectifier at engr. station 1038+70
CALIBRATION OF PIPE: @ engr. station 1010+80:

Amp	MV Drop	A/MV
17.1	11.85	1.444
10.95	7.65	1.432
8.0	5.55	1.441
		Avg.=1.439

@ engr. station 531+20:

18.8	13.3	1.414
11.0	7.8	1.410
		Avg.=1.412

SOIL RESISTIVITY MEASUREMENTS* (4-Pin Method):

Location Engr Sta	Current MA	Volts Depth-Ft	Equiv Depth-Ft	V/A	Multiplier	Resistivity Ohm-Cm
1010+80	13.9	.06	4	4.31	746	3,300
635+63	13.9	.06	4	5.42	746	4,040
531+20	5.1	.071	4	13.92	746	10,380

*Each measurement is average of 5 readings.

COATING RESISTANCE MEASUREMENTS:**

Location Engr Sta	P/S Volts On	Off	Delta V	MV Flow On	Off	Delta MV	Equiv Current Amp
Case 1 — Drain current=6 amp							
1010+80	2.18	1.01	1.17	1.416	—	1.416	2.04
889+83	2.00	1.06	94				
740+27	1.81	1.03	78				
635+63	1.75	1.06	69				
531+20	1.69	1.07	62	.61	—	.61	861
Case 2 — Drain current = 12 amp							
1010+80	4.01	1.20	2.81	3.70	—	3.70	5.32
889+83	3.55	1.19	2.36				
740+27	3.13	1.19	1.94				
635+63	2.91	1.18	1.73				
531+20	2.71	1.20	1.15	1.62	—	1.62	2.29
Case 3 — Drain current = amp							
1010+80	5.50	1.20	4.30	5.80	—	5.80	8.34
889+83	4.81	1.21	3.60				
740+27	3.99	1.03	2.96				
635+63	3.69	1.06	2.63				
531+20	3.50	1.15	2.35	2.55	—	2.55	3.60

**Each measurement at 1010 + 80 and 531 + 20 is average of at least 10 readings.

COATING RESISTANCE CALCULATIONS:

	Avg. Delta V	Amps. collected	Total resis	Linear dist—ft	Sq ft per ft	Avg. coating resis for one sq ft area
Case 1	.84	1.18	.712	47,960	2.26	77,200 ohms
Case 2	2.07	3.03	.684	47,960	2.26	74,200 ohms
Case 3	3.17	4.74	.669	47,960	2.26	72,600 ohms

with molecular weights ranging from 580 to 700. The average number of carbon atoms per molecule ranges from 30 to 75. Naphthenes and isoparaffines make up a greater part of the microcrystalline wax. Refining techniques and origin of crude oil determine the relative proportion of the various components and therefore the properties of the finished microcrystalline waxes.

Actually, microcrystalline wax is nothing more than solid oil. Being such, it has many attributes of oil. First, it has almost complete inability to absorb moisture. Being unable to absorb moisture, it cannot transmit moisture to the pipe surface. Further, wax wets the metal pipe surface much as do oils and greases. Once applied, wax cannot be removed by mechanical means. Microcrystalline waxes are pliable and will accommodate expansion, contraction, and general flexing of the pipe surface. Field reports state that microcrystalline wax has self-healing properties, no doubt as a result of this permanently pliable nature.

On the other hand, microcrystalline wax, unlike oils and greases, sets up with a firm body at ground temperatures. (See penetration at 77 F.) It contains no light ends that may diffuse out of the coating with age. Further, the microcrystalline wax is unaffected by any chemicals commonly found in the soil.

. . . and the Plastic Wrapper

Though inert and not subject to deterioration, because of its very ductile nature, wax may be subject to some degree of deformation under certain soil pressures. For this reason wax coatings must always be separated from the soil environment by a tough and permanent barrier. In this case, polyvinylidene chloride film was used. Physical properties of polyvinylidene chloride plastic are tabulated in Table 2. Resistance of this plastic to chemicals is tabulated in Table 3.

Microcrystalline waxes have been used as a pipe coating material for as long as 30 years without deterioration when properly protected from the soil. Polyvinylidene chloride plastic film has been used in underground installations for as long as 13 years without any significant change in its physical or chemical properties.

Theory of the microcrystalline wax-plastic film coating and wrapping system is that, if the wax with its permanent water-proofing properties can be permanently protected from the mechanical pressures of the soil environment, the protection of the metal surface of the pipe itself will indeed be permanent.

Further, the high dielectric strength of the plastic film supplementing the dielectric properties of the wax will efficiently and without increasing of current requirements, support the negative voltage of the cathodic protection and with no ill effects from excessive overvoltages.

How It Performs

During the summer of 1955, a survey of cathodic protection requirements for this line was made by Cathodic Protection Services, Inc., Houston, Texas. As a result of this survey, a 22-v, 25-amp rectifier was installed at the approximate mid-point of each of the two 40-mile sections of this line. Initial readings made in October 1955, as well as subsequent readings are tabulated in Table 4. Pipe-to-soil gradient from the rectifier to the extremities of each 40-mile section is plotted in Graph 1.

During the last four years it has been possible to make visual inspection of the wax coating and plastic wrapper on this line. On several occasions where the line has been exposed by washes, or dug out to make tile repairs, the coating and wrapping has appeared to be in perfect condition.

Summary

After four years, the protection on this 76.9-mile line protected by the microcrystalline wax-plastic film system appears to be excellent. Current requirements are low. Visual inspection shows no deterioration in either coating or wrapper. A periodic check will be made to detect any increase in current requirements, other than seasonal, and to observe any deterioration of either coating or wrapper. ★ ★ ★

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Two hundred million cubic feet of gas per day will flow smoothly through TGT's 355-mile "Muskrat Line." There'll be no turbulence — no restriction to flow set up by the mainline valves, because they are W-K-M Through-Conduit Parallel Expanding Gate Valves. These efficient valves assure full volume — smooth flow — all the way. Scrapers will go through them as easily as they do through the pipe.

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For proved performance and minimum maintenance, specify W-K-M Pipeline Valves. Ask your W-K-M Representative or write today for new Pipeline Valve Catalog #300.

*Trade Mark of W-K-M Manufacturing Company, Inc.

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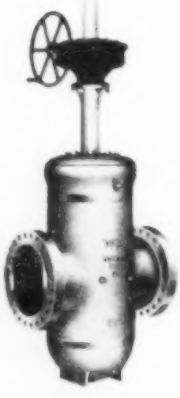

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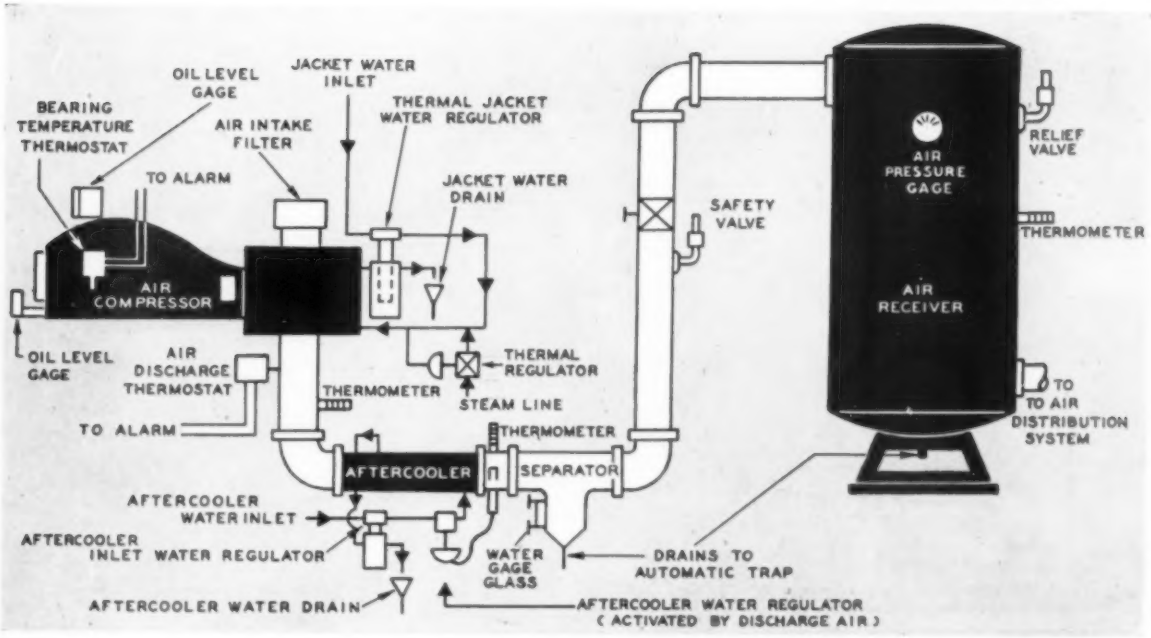

Here are some tips to help you . . .

Improve Your Compressed Air Supply

R. A. Schaefer
Worthington Corporation

ARE your air compressor facilities well-engineered? Have you checked them lately against good practice? It is quite possible that your compressed air supply plant is limping along without some of the mechanical accessories that are important functions. These are shown in the accompanying layout diagram. Perhaps, your facilities do not need all of these accessories. But you should know what each does and how it does it. From this, you can determine whether these accessories will improve your operations.

The following are the good practices to be looked for, and ones that are necessary to the installation and operation of air compressors.

Air Filtering

No air compressor should be without an intake filter, no matter where it's located. Open suction piping is the surest and fastest road to costly damage. Dirt, grit, and even insects that are swept into a cylinder will gum up valves and rings. Also, they will abrade the moving parts. I know of one compressor with a wide-open intake that was dismantled to find why it lost capacity. A blueprint and several rags were fouling the valves.

Good filters can be obtained for almost any condition at reasonable cost. Viscous-impingement types will do for average conditions. Oil-bath units are used for heavily laden air. In nonlubricated carbon ring compressors, where the air cylinder must be kept free from oil of any kind, use a dry-type filter with felt and wire-mesh elements.

Keep snow or rain out of the intake, too. A hood or set of louvers placed before the filter will do the trick.

Never locate the intake opening near

steam exhausts or paint spray booths. Place it where the air is least contaminated. Brace the intake flue with extra supports to avoid putting undue strain on the cylinder on which it hangs.

To get the best efficiency from the compressor, draw your intake air from as cool a source as possible. Each 5-deg change in the suction temperature affects the volumetric efficiency of the compressor by about 1 per cent.

Aftercooling

One of the best ways to keep moisture out of compressed-air distribution lines is to take it out by an aftercooler before the air enters distribution system.

For example, 1000 cu ft of saturated air at atmospheric pressure and 80 F contains 1.58 lb of moisture. If this air is compressed to 100 psig and then cooled in an aftercooler to 80 F, the moisture content will be only 0.195 lb. The difference of 1.385 lb is separated and drained out by the aftercooler. An automatic moisture trap is recommended to drain this condensate periodically and thus preserve the efficiency of the separator at all times.

Aftercoolers come in a variety of shapes and sizes. They range from tube-and-shell type, in either vertical or horizontal position, to the boxlike tank-and-coil type with cooling water open to atmospheric pressure. The pipe line type is popular because it can be installed as part of the air distribution line.

Air Receivers

The air receiver has become such an accepted part of the compressor plant that we tend to lose sight of its important functions.

There are tanks and bigger tanks for any job. But what is the right size? The proper selection of one or more tanks is based not only on the capacity of the compressor itself, but also on the shop load cycle, as you'll see later in a formula.

The receiver acts primarily as a pulsation damper and warehouse for air. But it is also a condensate collector. Moisture and oil drop to the tank bottom because of the decreased air velocities in the tank. So it's wise to use automatic moisture traps to pass off the condensate. If you don't drain the tank regularly, you cut its capacity.

In many cases it pays to install one or more extra receivers farther on in the system. By installing a tank in a long distribution line, or at a point of intermittent heavy demand, you obtain a system that can cope with maximum load periods. Also you minimize the chances of excessive pressure drop during heavy loads.

Go easy before ordering that extra compressor. Before you buy, make a rough check on your storage capacity by using the following formula. You may find that an extra receiver is all you need:

$$T = \frac{V(P_1 - P_2)}{CP_a}$$

Where T = time in minutes receiver will supply air from upper to lower pressure limits.

V = volume of tank, in cubic feet.

P_a = absolute atmospheric pressure, psia

P_1 = maximum tank pressure, absolute (compressor discharge pressure).

P_2 = minimum tank pressure, absolute (pressure required to operate tool)

C = cubic feet of free air needed per minute (from study of load cycle).

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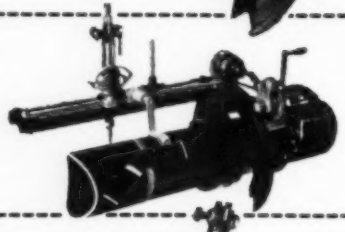

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Protective Devices

Whether your compressor set-up is of the central-station or multi-area type, you can profit by the use of many simple mechanical controls and protective devices. Refer again to the installation diagram.

Relief valve. Every system needs a relief valve on the air receiver and compressor intercooler (if more than single-stage) to guard against damage from high pressures. Have you got one? Is it working? Might be a good idea to test it and see.

Safety valve. A safety valve (usually of the spring-loaded type) should be installed in the line between the compressor and the shut-off valve leading to the air receiver. Be sure its capacity is enough to handle the compressor capacity.

Cutting costs by undersizing this valve doesn't pay. If you're lucky, you might get off with blown motor fuses during an overload. But it could cost you a cracked compressor cylinder.

Shut-down controls. Thermostatic shut-down controls for detection of high temperature in bearings and discharge air can prevent serious trouble. In these controls an excessive rise in temperature at the point being guarded will break an electrical contact, open the starter circuit, and thus stop the motor.

In one installation, the heat of the discharge air had risen to a point where the operator had about decided he needed a larger aftercooler. In checking over the unit a service engineer found the oil feed had run dry. Piston, cylinder, and rings were all badly scored, and required expensive repair. A thermostatic watchman in the discharge line would have prevented this.

Normally such bearing temperature protection is used only on larger compressors. But you'd be wise to consider it for smaller machines, particularly if the operation is round-the-clock or of a critical nature.

Overspeed trips. Steam-driven units need overspeed trips to guard against governor failure. They also need safety stops to shut off the steam supply should the governor chain linkage fail.

In a typical stop guard, a pivoted pulley rides on top of the chain during normal operation. If the linkage breaks, the pulley drops and releases a spring-loaded lever. This in turn forces the governor valve to seat, shutting off the steam supply.

Don't overlook the advantages of a relief valve on the steam cylinder to protect it against the dangers of condensate accumulation. It takes only one revolution in a water-clogged cylinder to blow the works.

Oil-pressure failure device. On compressors with force-feed lubrication, a shut down device for oil-pressure failure is becoming standard equipment. If your compressor doesn't have one, you can buy one for about $35. It works the same as a thermostatic control, except that an oil-pressure drop shuts off the motor.

Recording instruments. Where compressors are remotely mounted, pressure and temperature recorders are a

The Author

Robert A. Schaefer is an application engineer for Worthington Corporation in Buffalo, New York. A former student of University of Buffalo, school of engineering, Schaefer spent 8 months in the U. S. Army Signal Corps. He joined Worthington in July, 1942, and has served as dispatcher, test engineer, chief inspector compressor test, compressor specialist, export department. He has also spent some time in compressor research, field work for compressor engineering and published a number of papers dealing with compressors.

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good investment. They tell you all you need to know about operations and help to diagnose symptoms of trouble.

Thermometers

On important installations, you will want to check the operating characteristics such as pressure, temperature, and load. Most installations have a pressure gage on the air receiver, but not a thermometer. A thermometer here will show how well you are using receiver capacity to store air — the hotter the air, the less weight you can store. Should the receiver air drop below 32 F, make sure that condensation can't freeze and crack the drain.

Thermometers in the air line at the compressor air discharge and on the downstream side of the aftercooler also are good check points. Valve leakage and resultant re-compressing of air will jack up discharge temperature. If you exceed, say, the normal range of 350 F to 380 F in a single-stage unit, you know there is trouble.

In most aftercoolers a downstream air temperature 10 to 15 deg above inlet water temperature is a good goal. Failing this, your heat transfer is not good. You may need more water, or the tubes are scaled up.

Optional Devices

There are protective and conservation measures that may boost operating efficiency, but their use is optional. Not many installations would justify their cost.

Aftercooler water, for instance, can be controlled by a regulator similar to that of the compressor proper (see diagram). That is, the inlet flow can be regulated by changes in the aftercooler water outlet temperatures. Probably a better arrangement would be to control the inlet water by activation from the discharge air temperature on the downstream side of the aftercooler. A rise in the air temperature would cause the regulator to admit more water into the shell, thereby providing a greater quantity for heat transferring purposes.

In many installations the aftercooler water piping system is in series with the compressor jacket water piping, so that a single regulator can be used for both. Frequently this arrangement will permit elimination of preheating equipment for the jacket inlet of the compressor. The cooling of the air in the aftercooler will raise the temperature of the outlet water high enough to run it directly to the compressor.

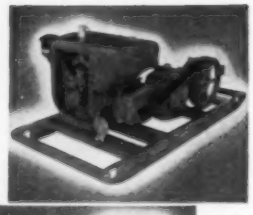
Thermostats used for detection of high temperatures in the air and running gear can also be connected to noise alarm systems. Mercury pressure switches can be used to warn of excessive pressure drops. At a predetermined low-pressure point the mercury will close the alarm circuit, setting off a noisemaker.

To be ultrasafe, protective devices to monitor other protective devices are sometimes used. It depends upon the state of mind of the particular engineer. While too many safety measures can never be a "bad" thing, they can become expensive if not carefully and selectively chosen.

Jacket Cooling

An air compressor operates best with the water jacket lukewarm to the touch, or about 105 F. At that temperature you get a minimum of condensation when the hot air hits the cooler jacket. This means less chance of valve erosion or premature wear of piston rings.

But watch out for too great a temperature difference in inlet and outlet water. Extremely cold inlet water will set up dangerous stresses and cause warpage of the air cylinder, even if outlet temperature is normal. The rule is to keep cooling water temperature 15 to 20 deg above that of the incoming air. And maintain about a 30-deg difference in the inlet and outlet water. Also, keep outlet water below 140 F. Too high a temperature affects proper lubrication.



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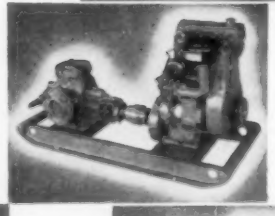

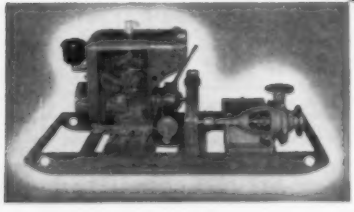

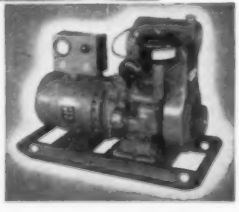

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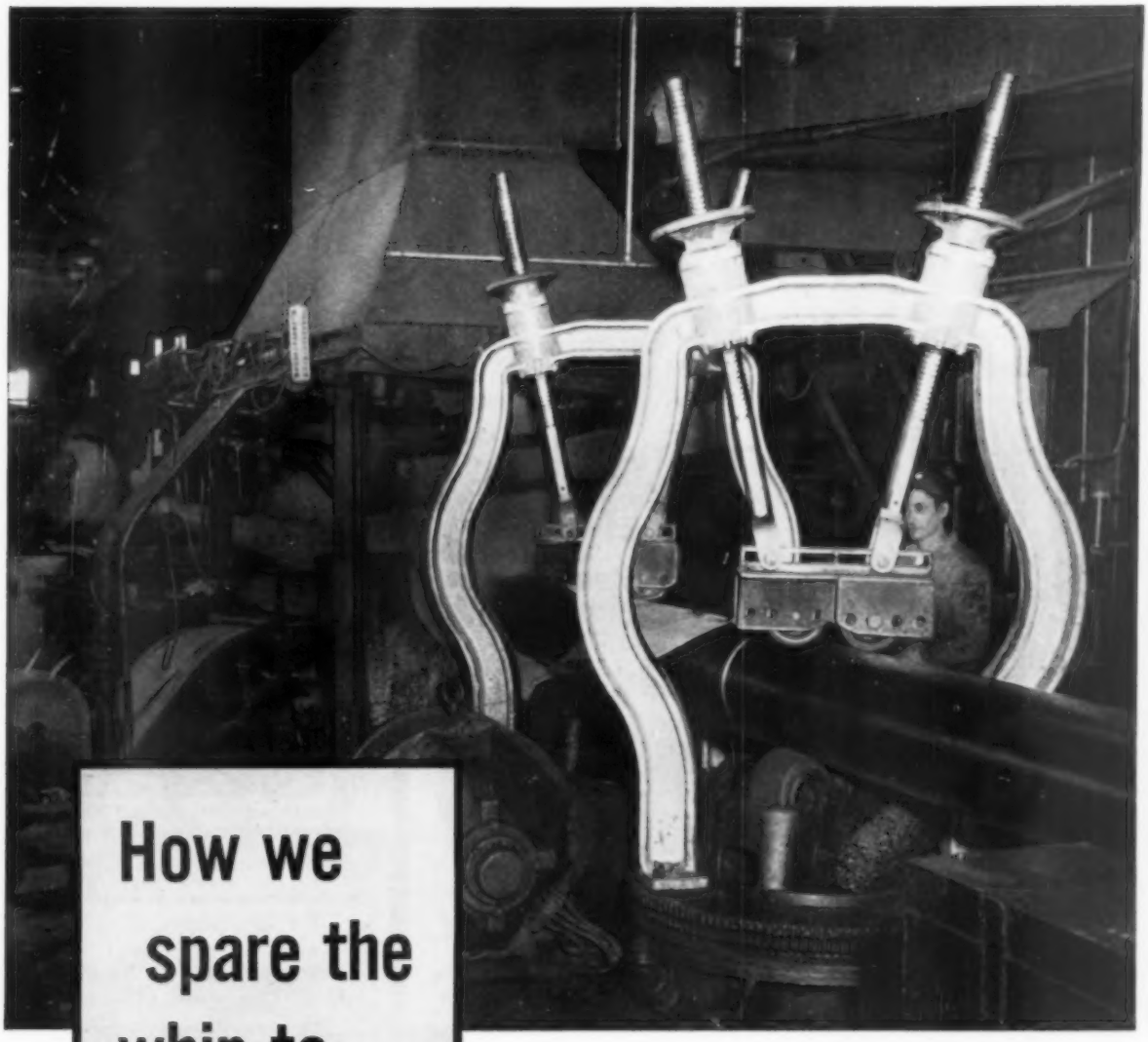

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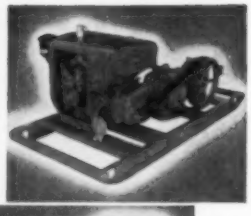

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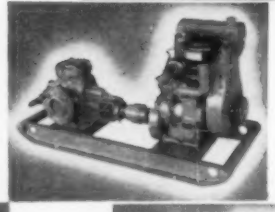

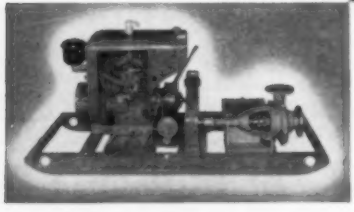

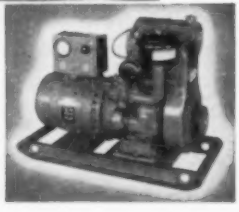

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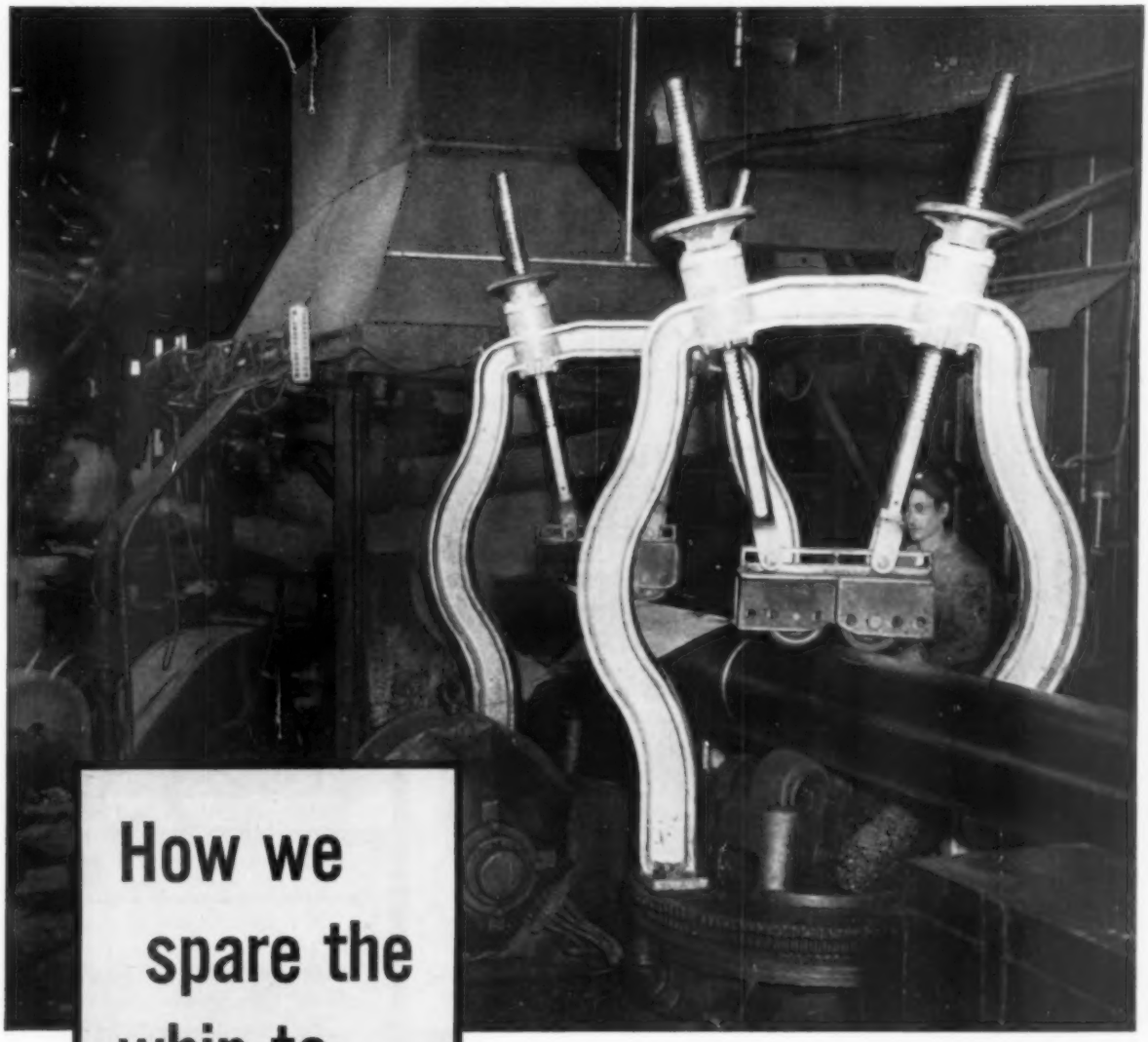

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You can raise the temperature of the inlet water, if necessary, by a small jet of steam. A thermally activated steam valve, hooked up as shown in the diagram, will regulate the steam supply according to the temperature of the incoming water.

One of the most useful controls, the water regulating valve, is often overlooked because its full value is not realized. Take a typical 500-cfm compressor operating six hours a day, of which three are in unloaded state. With a regulating valve you can save hundreds of gallons of water by closing off the jacket water supply during periods when the plant is idle.

The water-regulating valve, either diaphragm or solenoid operated, can be wired so as to operate only on shutdown and starting of the compressor. Or you can adjust it to throttle down the supply during the unloaded state, when only friction heat needs to be removed. Where electricity is not available, the valve can be activated by air bled from the unloaders, and vented back through these same lines upon resumption of load.

Another device to aid in efficient operation and water conservation is the throttling valve actuated by the temperature changes in the outlet water. The detecting element is inserted in the water outlet piping as shown in the diagram. The valve is installed in the inlet water line. An increase or decrease in outlet water temperature increases or decreases the valve opening.

Not enough cooling water can be as bad as too much cold water. It permits the temperature of the discharge air to go too high. Then the viscosity of the lubricating oil changes or breaks down, leading to prematurely worn parts. So why rely on undependable manuel adjustment when you can install automatic regulators at reasonable cost!

Moisture Removal

Start thinking about moisture removal right at the air compressor. Moisture in the system causes early tool wear and breakdown. It isn't good at the compressor, either. It dilutes the lubricating oil, and, among other things, causes premature cylinder wear.

Efficient moisture removal depends on proper slope of pipes and generous use of traps and separators, or "knock-out drums." At the air compressor, incline the air inlet piping toward the cylinder, with a drop leg, or even better, a separator for intercepting moisture in the air flow directly ahead of the cylinder suction port. The air discharge line should slope away from the air compressor outlet. ★ ★ ★

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Manufacturers to Build New Compressor Station

The Federal Power Commission has authorized The Manufacturers Light and Heat Company, of Pittsburgh, Pennsylvania, to construct and operate a 5280-hp compressor station and other related facilities in Marshall County, West Virginia. The cost is estimated at $3,588,000.

The new compressor station will replace the existing 2500-hp Majorsville compressor station in Washington County, Pennsylvania, approximately one-half mile from the site of the proposed station.

Skelly to Extend Pipeline Into Nichols Field, Kansas

Skelly Oil Company will extend its pipeline system in southern Kiowa County, Kansas, to include the Nichols field. It will be an 8-in. 30-mile extension, scheduled for completion in the fall.

Skelly has been purchasing trucked crude from the Nichols field for several months.

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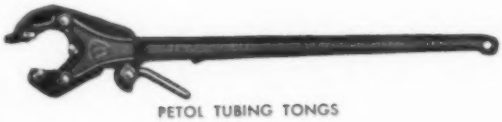

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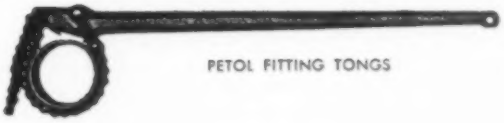

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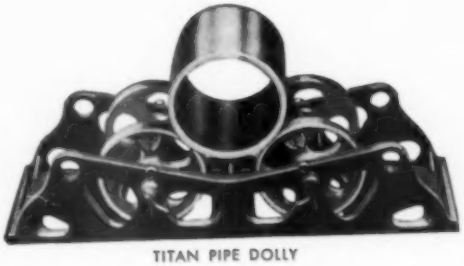

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Howard Segool, of Polyken Tape, had a red face and a bright, shiny combination traveling alarm clock-barometer-thermometer when he left the annual NACE meeting in St. Louis. Howard's charming wife, **Virginia,** was visiting the vast exhibit area. At the booth of a competitor of Howard's company (the competitor sells coal tar enamel pipe coating, Howard sells a tape-wrap), Virginia was invited to "sign up for a prize drawing." She did. Returning some time later, she was asked to make the drawing from a box. Refusing politely, she explained, "I might draw my own name." "Hardly possible," said the man at the booth, "and we always like a charming lady to draw the name slip." So Mrs. Segool drew the card — and sure enough, she drew her own name. The attractive gift was passed on to hubby, who "can use it more than I can, since he's always traveling," she declared.

O. W. Wade, Transconintental Pipe Line's busy-as-a-bee corrosion engineer, and **Bill Huddleston,** of Huddleston Engineering in Bartlesville, Oklahoma, have a lot more in common than corrosion. Both are good musicians, as those who attended the annual "Thursday night at NACE" party will attest. Wade and Huddleston, playing the electric guitar and piano, respectively, teamed up to provide top-flight entertainment, with singing by the ladies. The party, an annual affair in recent years, attracts a big crowd of folks who like both the good old tunes and modern classics. **Hans Schmoldt,** Bill's right-hand man, tape-recorded some of the proceedings and they, too, sounded good. Among the sponsors of the party who had a nice greeting for everyone attending were **Don Westbo** of Enamelex of Texas, **Wayne Broyles** of Brance-Krachy, **Jack Royston** and **Lou Royston** of Royston Labs. Lou incidentally, sings nicely in Spanish, a talent we never suspected. **Mark Battersby** of Farwest Corrosion Control Corporation was an able bartender for the canarying group.

In the lobby of the Sheraton-Jefferson, after-hours GHQ for all pipeliners and other corrosion people, we spotted **Ted Kennedy Jr.,** of The Trenton Corporation . . . **K. B. Shearon,** of Shearon, Inc., Houston, an able story-teller . . . **Lance Heverly** of Ohio Oil Company, working up business for his early summer Appalachian Corrosion Short Course . . . **Elmer Westerhoff** of Consumers Power Company, Jackson, Michigan . . . **B. J. DeHanas** and **Jim Hunter** of Service Pipe Line Company. **Paul Mallette** and **Jim Stanford** of Visco Products were spotted in the coffee shop inhibiting their java . . . **Benny Means** of Pitt Coke and Chem, extending long-time-no-sees.

Seen in the corridors: **Frank Burns** of Kerr-McGee Oil Industries . . . **J. E. (Jim) Poole,** now a manufacturer's rep . . . Betz Lab's **Otto Preis,** checking the water for conditioning . . . **Melvin Romanoff,** Bureau of Standards and author for *The Pipeline Engineer* . . . **Henry Hughes,** Reilly Tar's Dallas man . . . **John Snider** of C-R-C . . . **"Red" Olive** from Arkansas Fuel Oil "Corps" (so his badge said) . . . **Bill Curley** of Houston and Royston Labs . . . **Jess Krueger** of Northern Natural.

Lots of familiar faces were on hand for NACE's Tuesday evening reception and Wednesday banquet . . . **Fred Stull** of Texas Gas . . . **T. D. Williamson Jr.** of T. D. Williamson, Inc. . . . **Walt Noser** of Humble . . . **George Purdy** and **Fred Hubler** of Tretolite, whose after the reception get-together was a highlight of the week . . . **Hugh L. Hamilton** of A. V. Smith Engineering, who is now registering from Toronto, Ontario, Canada . . . **Jack Harris** of Rockwell Manufacturing up from Houston . . . **Tom and Mrs. Holcombe** from Shreveport, extending good ole southern hospitality . . . **Bob Johnson** of Kraloy Plastic Pipe, in from Los Angeles . . . **Thomas F. P. Kelly,** Mavor-Kelly Company, waiting for St. Patrick's Day . . . **Austin Long** from the Glidden Company . . . **Richard Lowe,** who came across the Atlantic from London to attend the show; he's with Cathodic Corrosion Control in England . . . **John Rasor** of Tinker and Rasor was on hand, too, . . . **Ed Noppel** of Ebasco Services, New York. . . **Maurice Riordan** from Rio Engineering, Houston . . . **Ronnie Poole and Jack Scott** of C-R-C . . . **Al Stegner and his charming wife,** from Tennessee Gas . . . **Maurice Belson and Ned Stearns** from D. E. Stearns Company, Shreveport . . . **Herb Van Nouhuys,** Southeastern Pipe Line, Atlanta, Georgia . . . **Ladd Wilson** and **Bob Driggs** of Nicolet Industries, New York . . . **L. F. Bramble** of Gulf States Asphalt, Houston.

At board of directors' meeting, NACE, St. Louis, during annual conference. Left to right: Jack P. Barrett, Pan American Petroleum Corp., Tulsa, South Central Region chairman; C. G. Munger, Amercoat Corp., South Gate, Calif., director; L. L. Whiteneck, Plicoflex Corp., Los Angeles, vice president; W. H. Stewart, Sun Pipe Line Co., Beaumont, president, and W. F. Fair, Jr., Koppers Co., Inc., Tar Products Division, Pittsburgh, immediate past president.

At the NACE annual banquet, left to right: H. F. Haase, consultant, Milwaukee, director; E. C. Greco, United Gas Corp., Shreveport, La., new chairman of the Technical Practices Committee; C. P. Larrabee, U. S. Steel Corp., Monroeville, Pa., past chairman Technical Practices Committee; H. R. Brough, Mountain Fuel Supply Co., Salt Lake City, Utah, director; Thor N. Rhodin, E. I. duPont de Nemours & Co., Inc., Wilmington, Del., who received the 1956 Young Author Award.

GASO HORIZONTAL TRIPLEX PLUNGER PUMP

FIG. 3466—2½" TO 3½" x 4"

MAXIMUM SPEED: 250 R.P.M.
MAXIMUM CAPACITIES AND PRESSURES:
91 Bbls. per Hour at 1180 p.s.i.
179 Bbls. per Hour at 600 p.s.i.

A NEW GASO MODEL

GASO'S Figure 3466 Horizontal Triplex Plunger Pump is a rugged 4" stroke high speed single acting plunger power pump for use where moderate capacities and medium to high pressures are required for crude oil gathering systems, movement of refined petroleum products, salt water disposal, water flooding and fresh water supply.

These pumps are available in complete skid mounted pumping units with gas, gasoline, or diesel engines or electric motors of various makes to suit the customer's preference. Horse power requirements will vary with pump speeds, plunger sizes, and working pressures. Consult our sales and engineering staff for recommendations and suggestions. Each unit will be properly engineered to suit your needs.

Construction Features of this pump emphasize simplicity and strength, a minimum number of parts, and easy maintenance.

The Power Frame is a high strength close grained grey iron casting, fully enclosed. All moving parts in the power end are self lubricated by splash system from oil in the crank case.

The Crank Shaft is a heavy alloy steel casting riding in large tapered roller bearings, 3" I. D. x 7½" O. D. x 2¼" wide, mounted in each side of the power frame. One end of the shaft extends to the outside of the power frame for mounting V-Belt sheave or coupling. This permits the driving power to be transmitted directly to the crank shaft. This shaft extension is 2 15/16" diameter and can be from either side of the pump.

Connecting Rods are steel castings with renewable babbitt lined steel shell bearings 3¾" I. D. x 3" wide in crank end, and bronze bushings 2" I. D. x 3" wide in the crosshead end.

Crossheads are cylindrical type semi-steel castings 7" O. D. x 7" long with outer surface ground and polished and lube-lok coated. The crosshead pins are hardened and ground steel pins, 2" diameter.

The Fluid End Body is a single piece casting. Molybdenum alloy iron is standard for crude oils, petroleum products, and fresh water. Aluminum bronze alloy is standard for salt water. Cast alloy steel bodies can also be furnished when special safety specifications demand it.

Cylinder Heads and Valve Chamber Covers are interchangeable. They are either alloy cast iron or aluminum bronze alloy, same as standard fluid end bodies. "O" Ring gaskets are used with these parts.

Standard Plungers for crude oil service are alloy steel, and for salt water service are bronze or stainless steel. Ceramic plungers and hard colmonoy surfaced steel plungers are also available on special order. Regular plunger sizes are 2½", 2¾", 3", 3¼", and 3½".

Fluid End Plunger Stuffing Boxes are sufficiently deep for receiving various types of standard packing rings for pumping ordinary self lubricating fluids. When necessary, the pump can be equipped with a force feed lubricator and special packing sets for plunger lubrication.

The Packing Glands are either alloy iron or aluminum bronze alloy castings. Three studs and nuts for each gland provide for even take-up.

Valve Assemblies for suction and discharge are interchangeable. Standard equipment consists of stem guided Durabla stainless steel valve discs and hard bronze seats or cast iron seats.

Dual 4" 150# ASA Suction Flanges and dual 2" 600# ASA Discharge Flanges provide for pipe connections to both sides of the fluid end.

Net Weight of pump is 2150 pounds.

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Edmonton, Alberta, Canada—Lufkin Machine Co. Ltd.

This view of Wamsutter station in wintertime indicates one of the problems that existed since it was first constructed in 1939 until the recent modernization.

Modernization AT WAMSUTTER Simplifies Operations

Deep snows and high winds were hampering factors, now operator does not leave station building except to make occasional visual inspection.

Howard E. Keith
Assistant Manager Industrial Relations

John T. Burton
Division Engineer
Utah Oil Refining Company, Pipe Line Department

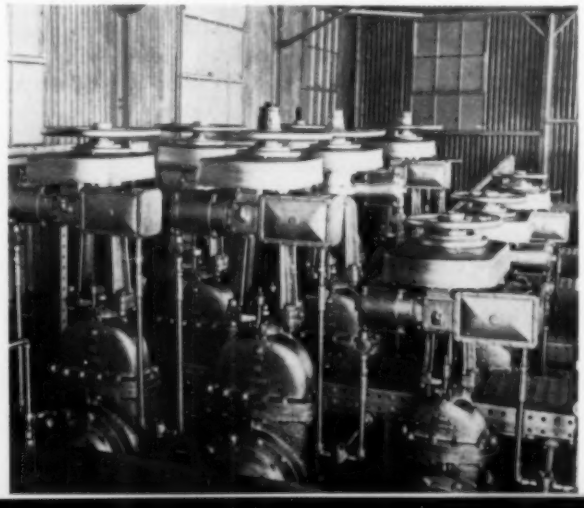
Pump room. Cabinet in wall (right center) provides access to high pressure oil lines connected to recording and indicating gages on engineer's desk.

SITUATED in the Red Desert country of southern Wyoming, only 12 miles west of the Continental Divide, is a veritable oasis — modern homes, neat buildings, green grass, growing trees and plants. In the summertime it is a marked contrast to its surroundings. In winter, the contrast disappears and the modern setting becomes merely a break in the wind-swept countryside with its alternate bare ground and snow — snow that drifts wherever anything, regardless of size, interrupts the onrushing winds.

The modern setting constitutes Utah Oil Refining Company, Pipe Line Department's Wamsutter station and the location has created operations problems from the beginning.

Constructed in 1939 as a booster station on the company's 8-in. crude oil line from Ft. Laramie, Wyoming, to

Fifteen gates in tank manifold were equipped with explosion-proof electric-motor-driven operators. Gates are operated from control panel in engine room.



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The Authors

H. E. Keith

J. T. Burton

Howard E. Keith is a native of Illinois. He joined Stanolind Pipe Line Company in 1936. Became associated with Utah Oil Refining Company in 1949 when that company assumed operations of the pipeline facilities formerly operated by Stanolind. He was made assistant manager of Industrial Relations in 1951.

John T. Burton graduated University of Utah in 1948 with a civil engineering degree. He has been employed by Utah Oil Refining Company, Pipe Line Department since 1949, and has headed the department's engineering staff as division engineer since 1952.

Salt Lake City, Wamsutter was originally a two-unit installation. The period from 1944 to 1949 saw additional and replacement units being installed (there are now five) to handle crude from two new incoming lines carrying production from Rangely, Iles, Wilson Creek, and other fields in northwestern Colorado. During this time, also, the stream of the 8-in. had been changed so that Wamsutter was pumping both ways (east and west through Utah Oil Refining Company's line) as well as north through a Service Pipe Line Company facility. As might be expected, additional batching became part of the operations.

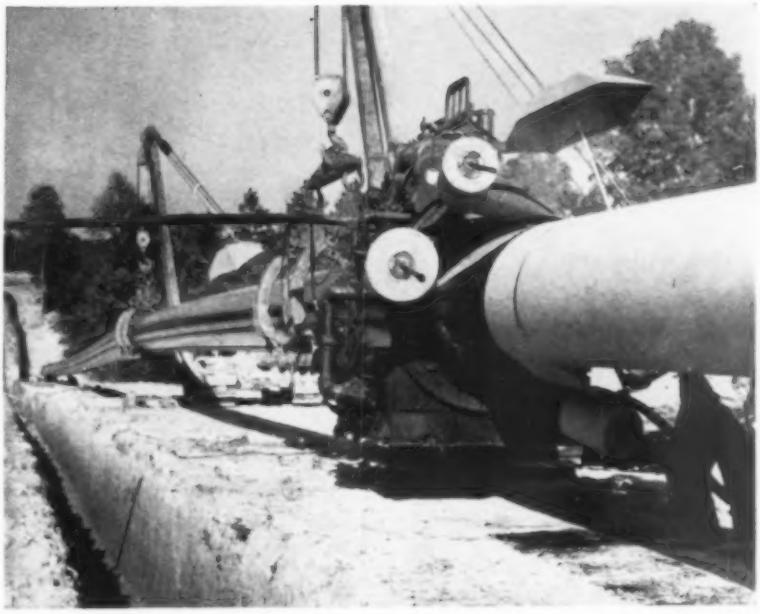
The size of the crew had been increased with the responsibilities.

Any employee who was at Wamsutter during the blizzard of '48 and '49 can tell some hair-raising tales (true, too) of the conditions. But *every* winter has brought problems and hardships to the men. Pneumatic tank gages proved undependable and it has been necessary to go to the tanks being worked for hourly checks. The many gate changes required by the operational setup have been made in the manifold, situated some 200 ft north of the station building. Two men were required for this. The three meters on the incoming streams are in the yard northeast of the station. When a different crude was due to arrive, it has required repeated trips to the meter area to obtain samples.

Modernization Program

During the fall of 1956, several revisions of facilities were made to modernize Wamsutter station operations.

Fifteen gates in the tank manifold



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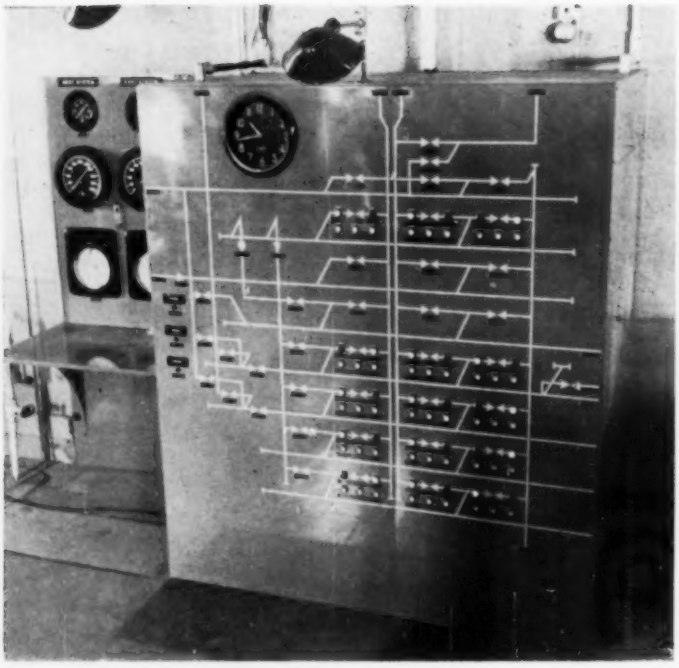
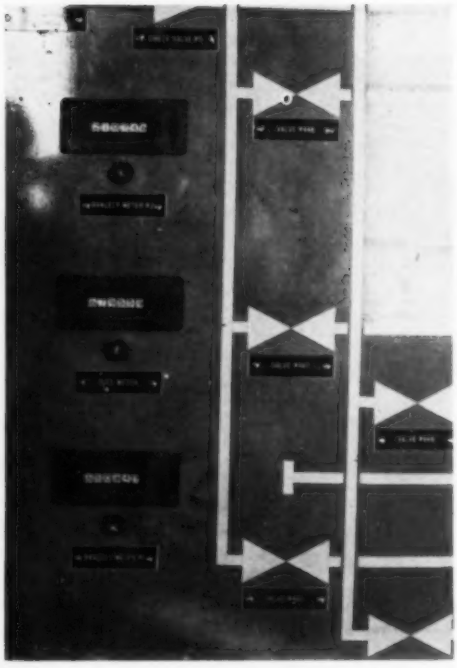


Control panel with its graphic layout of station piping. Meter counters are on left of panel, engineer's desk at extreme left.



Magnetic counters on control panel eliminate need for engineers to leave station to read meters.

were equipped with electric explosion-proof motor operators. A large control panel in the engine room has a graphic layout of the manifold piping. On this panel pushbuttons control gate valve operations and indicator lights show valve positions. The positive displacement meters on the incoming lines have been equipped with impulse type transmitters that activate magnetic counters on the control panel.

A gravitometer has been installed on the incoming line from Iles (the source of batched shipments) and by means of a differential transformer type transmitter, a remote reading receiver in the station records the line gravity and also lights an alarm when a batch interface has reached the station.

Tank gaging (with HI-LO level alarms) is now done by a pulse code electric transmitter at each tank. Tank level is read-out on a lighted tank gage panel in the station office. Also included in the modernization were improvements to the stations incoming and outgoing scraper traps. Each was provided with expanded barrels and quick-opening blanking plugs. Unit No. 3 was provided with a pneumatic controller, which is actuated by line pressure, and governs the speed of this unit to maintain predetermined pressure limits.

The station engineers' desk, situated immediately adjacent to the control panel, has on its back panel recording pressure gages for the east and west systems and for the No. 3 unit controller, 12-in. diam indicating discharge pressure gages, and 6-in. diam indicating suction pressure gages. The side panel of the control board cabinet holds the remote recording device and indicator lights for the gravitometer. The compartment behind the desk that houses the high pressure oil lines to the gages is of welded construction and is accessible only from the pump room side of the firewall. The wiring behind the control panel is accessible only from the engine room side. The two cabinets are entirely isolated from each other by a steel wall.

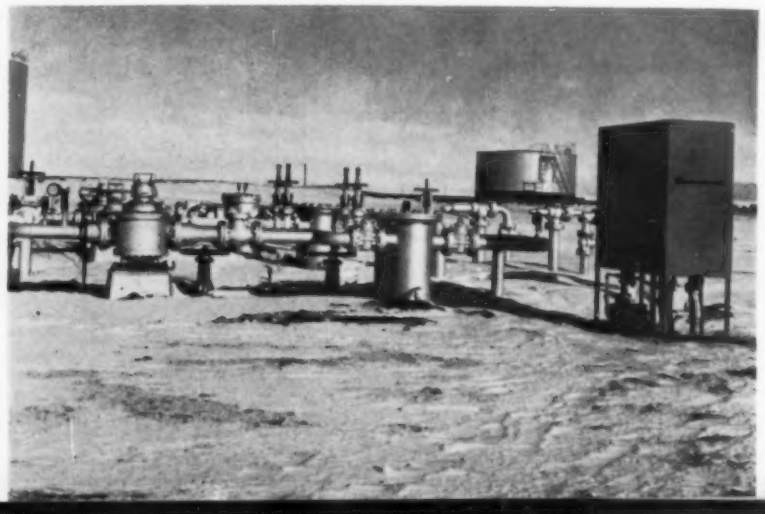
Pumping equipment at Wamsutter consists of two 280-hp engines direct-coupled to 2-stage duplex horizontal pumps, and 820-hp supercharged engine driving an 8-cylinder pump, and two 525-hp engines driving 5-cylinder pumps. Fuel is crude oil taken from the Iles stream.

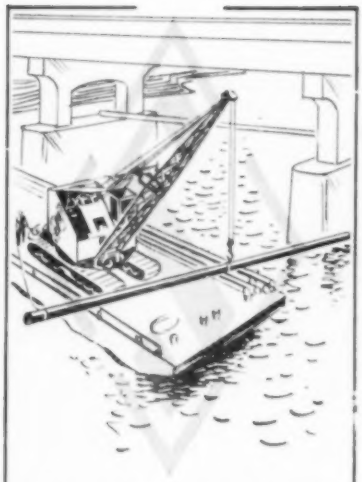
The new equipment installed during 1956 has simplified operations at Wamsutter to the extent that it is no longer necessary for the station engineer to leave his machinery except to make visual inspections. It permits operation with one man on tour whereas two were required previously.

Reduction in manpower requirements were anticipated with the result that only one man was transferred, two men had assumed other assignments, and one had resigned.

Utah Oil, Pipe Line Department, officials are confident that the expenditures of the past fall have resulted in a safer, better integrated, more economical station operation, while providing flexibilities that could be incorporated in future planning. ★ ★ ★

Meter area. Cabinet on right houses gravitometer.





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PIPELINE PERSONALS

C. L. Perkins, president of El Paso Natural Gas Products Company, was elected to the board of directors of Tekoil Corporation. El Paso Natural Gas Products Company is a wholly-owned subsidiary of El Paso Natural Gas Company. Perkins is vice president of the gas company as well as of Rare Metals Corporation of America, another subsidiary, and is a director of all three corporations.

C. F. Horton

Claude F. Horton has been elected executive vice president and a member of the board of directors of Construcciones Collins de Venezuela.

Horton was also named assistant to **S. V. Collins,** president of the firm, in contract negotiations for the Collins Construction Company of Port Lavaca, Texas. He was formerly vice president of Brown & Root, Inc., in charge of all pipeline construction.

Charles F. Guinn, superintendent of Tidal Pipe Line Company, a wholly owned subsidiary of Tidewater Oil Company, has retired. He has served almost 31 years with Tidal Pipe Line Company, working throughout Texas, Oklahoma, New Mexico, and Louisiana. He contributed to many of the major improvements in methods and techniques in pipeline developments. **Otis R. Tisdale,** chief engineer of Tidal Pipe Line also has retired. He has worked in many parts of Oklahoma, Arkansas, New Mexico, Louisiana, and Texas. During World War II, he was loaned to the War Emergency Pipe Line, returning to Tidal Pipe Line upon termination of hostilities.

The American Gas Association has announced the appointment of three men to positions in its headquarters office in New York City. **Samuel J. Cunningham** has been named research assistant to the research bureau. He was last associated with Cities Service Oil Company. **Joseph F. Giaccone** joins the staff of the bureau of statistics after 10 years with the American Transit Association, most recently as assistant to the director of the statistical department. **W. Roger Sarno** to the utilization bureau as assistant utilization engineer specializing in heating and air-conditioning. He was last with Babcock and Wilcox.

K. N. Bradley has been appointed senior engineer, Service Pipe Line Company. Bradley will have supervision of the civil, valuation, reconnaissance, drafting and records sections. In the same department, **T. S. Llewellyn,** senior engineer, will have supervision of the mechanical, electrical, utilities, corrosion, and research and development sections; and **V. J. Sittel,** assistant chief engineer, will direct and coordinate all engineering planning activities concerning pipeline system automation and microwave communication facilities.

R. H. Christman, contracting administrator, has been promoted to civil engineer to replace Bradley. **Fred W. Zilm,** former welding technician, has been promoted to replace Christman.

K. N. Bradley

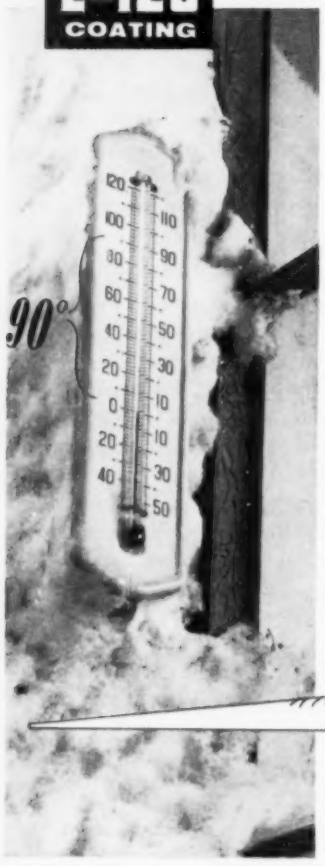
A. L. Roberts

A. L. Roberts, vice president of Texas Gas Transmission Corporation, has been named vice president in charge of operations, succeeding the late L. E. Ingham, who retired on February 1 and who died March 3.

Roberts was employed by Missouri-Kansas Pipeline Company, a predecessor of Texas Gas, as district superintendent at Bowling Green, Kentucky. He later served in the same capacity with Kentucky Natural Gas Corporation, another Texas Gas predecessor. When Kentucky Natural Gas and Memphis Natural Gas were merged into Texas Gas in 1948, supervision of construction of a pipeline system from Texas and Louisiana to Ohio was assigned to Roberts. He was appointed general superintendent of the Texas Gas system in 1949, and the board of directors elected him vice president in 1956.

LION E-120 COATING

EXPOSED COATING WITHSTOOD 90° DROP IN ONE NIGHT



FOR TWO WEEKS, eleven thousand feet of ten inch coated pipe was left exposed on a right-of-way in Colorado. During this period, the atmospheric temperature dropped from 90° to 0° Fahrenheit in a single night.

The coating material, LION E-120 asphalt, stood up and took this beating, saving the contractor the cost of a completely new coating job. At the end of the two weeks, a thorough test with a holiday detector revealed that there were no checks or cracks and, on the entire 11,000 feet of pipe, no disbonding had occurred.

This confirmed the results of laboratory tests in which pipe, coated with LION E-120 was heated to 140° F. — placed in a refrigerator at minus 20° for four hours — and brought back to 77° — with no sign of coating failure.

CALL US OR WRITE US *for complete specifications on* LION E-120 *coatings and literature on other* HOLCOMBE *corrosion prevention products.*

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Pipe Wrappings • Graphite Anodes • Coke Breeze

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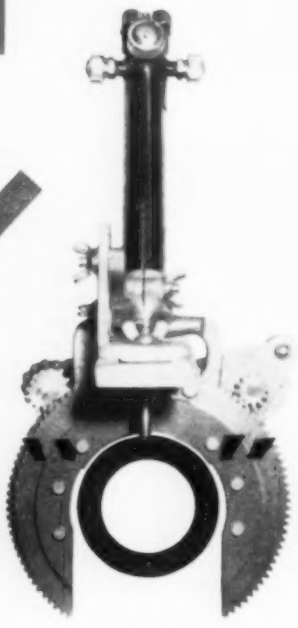
model "O" for small diameter pipe cutting and beveling



Welding of small diameter pipe (1½" to 4") becomes the easiest, quickest, most accurate — **and most economical** — means of joining such pipe when every cut and bevel is square and accurate.

The never-failing precision-action of H & M's exclusive Model "O" has been field-tested and proved on hundreds of welding jobs — **even** when operated **by apprentice welders!** A perfect cut and bevel can be made on 2" pipe, for instance, in less than 30 seconds actual cutting time — **by an inexperienced operator.**

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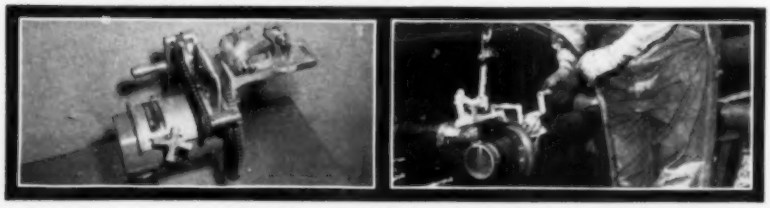

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Personals

G. P. Garver

M. V. Burlingame

J. J. Hedrick, president of Natural Gas Pipeline Company of America and of Texas Illinois Natural Gas Pipeline Company, has been elected president of Peoples Gas Light and Coke Company, effective June 1. Hedrick succeeds **Eskil I. Bjork,** who has been named chairman and chief executive officer of Peoples Gas and board chairman of the pipeline companies. This was announced after **James F. Oates, Jr.,** advised the board he will be leaving the companies about June 1. Bjork has been president of Peoples Gas since 1952. Succeeding Hedrick as president of the affiliated pipeline companies will be **George P. Garver,** who is presently vice president and secretary-treasurer of the pipeline companies. Hedrick will continue to play a vital role in the activities of the expanding pipeline companies, as he will fill the new office of vice chairman of the board of directors of the pipeline companies. A new position of executive vice president of the pipeline companies will be created, to be filled by **Mark V. Burlingame,** presently vice president in charge of operations.

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WITH THE PIPELINE CONTRACTORS

● **Houston Contracting Company, 2707 Ferndale Place, Houston 6, Texas.** Has 121 miles of 30-in. natural gas line for *Texas Eastern Transmission Corporation* from a point near Angleton, Texas, east to a point near Vidor, Texas. Work is being handled by three spreads; pipe laying began between March 2 and March 15.

● **H. B. Zachry Company, Box 2570, San Antonio 6, Texas.** Has 330,000 ft of 4½-in. line for *Phillips Petroleum Company* between Coke County and Midland County, Texas. Has three spreads of 30-in. line and river crossings for *Texas Eastern Transmission Corporation*. One spread of 353,700 ft extends from the Rio Grande River to the King Ranch; another, 358,500 ft between Port Lavaca and Highway 35. The river crossings are on the Rio Grande between McAllen and Vidor, Texas.

● **Panama-Williams Corporation, 1418 Melrose Building, Houston, Texas.** Has 76 miles of 4 and 6-in. line for *Phillips Chemical Company* between Pasadena and Sweeny, Texas. Also has 46 miles of 10-in. LPG and natural gasoline line to lay for *Gulf Refining Company* between the company's Waddell plant in Crane County, Texas, to Midland. Contracts for the remainder of this 530-mile line, extending to Houston, are yet to be let.

● **Majestic Contractors Limited, 408 Royal Trust Building, Edmonton, Alberta.** Has gathering system to lay for *Westspur Pipeline* in the Midale, Saskatchewan, area. Has undetermined amount of city distribution system for *Consumer Gas Company* in Toronto. Has 85 miles of 30-in. line — Section 7 — of *Trans-Canada Pipe Line, Ltd.*, natural gas line. This spread, with pipe laying to begin probably in June, is east of Winnipeg through territory largely muskeg and solid igneous rock.

● **River Construction Corporation, Box 9217, Fort Worth, Texas.** Has 84 miles of 8 and 10-in. line from Richmond to Stockton, California, to lay this string for *Southern Pacific Pipe Lines, Inc.*

● **Canadian River Construction, 580 Hornby Street, Vancouver, British Columbia.** Has 150 miles of gathering lines in northern Alberta and British Columbia for *Westcoast Transmission Company, Ltd.*

● **Ted Price Construction Company, Electra, Texas.** Has 205 miles of 1 to 8-in. distribution system in Walla Walla, Washington, and Pendleton and Baker, Oregon for *Cascade Gas Company*.

● **Troth Construction Company, Box 592, Britton, Oklahoma.** Has contract for 160 miles of 2 and 8-in. lines for gas distribution to communities in the Aberdeen, South Dakota, area, for *Northern Natural Gas Company*.

● **Engineers Limited Pipeline Company, 200 Bush Street, San Francisco, California.** Has line for *Pacific Gas & Electric Company* consisting of 37 miles of 20-in., 37 miles of 18-in., and 19 miles of 12-in. to lay from Beehive Bend field to Sacramento, California.

● **Fulton Banister, Ltd., 625 Northern Hardware Building, Edmonton, Alberta.** Has 33 miles of 24-in. for *Interprovincial Pipe Line Company* between Peebles and Glenavon, Saskatchewan, to begin construction about June 1. Also has about 130 miles of 1 to 20-in. distribution lines in Regina City, Saskatchewan, for *Saskatchewan Power Corporation*.

● **Mannix, Ltd., 322 Seventh Avenue W., Calgary, Alberta.** Has 100 miles of 3 to 12-in. gathering line in the Pembina field to lay for *Pembina Pipeline Company, Ltd.* Has 110 miles of 30-in. for *Westcoast Transmission Company, Ltd.*, between Huntingdon and Kingsvalle, British Columbia. Has 90 miles of 34-in. to lay for *Trans-Canada Pipe Line Company* between Moose Jaw and Candiac, Saskatchewan. Has contract to lay 32 miles of 16-in. loop for *Pembina Pipe Line Company, Ltd.*, between Edmonton and Calmar, Alberta. Work on this project is to begin May 1.

● **Collins Construction Company, P. O. Box 86, Port Lavaca, Texas.** Has contract for laying 37,000 ft of 22-in. pipe for the *City of Los Angeles*, California. Line will serve as ocean outfall for sludge from Hyperion Treatment Plant at El Segundo, and will extend from El Segundo beach to a depth of 300 ft in the Pacific Ocean. Also has 11,000 ft of 4-in. pipe to lay for *Pan American Petroleum Corporation* from McFaddin Beach Dome near High Island to a producing well offshore in the Gulf of Mexico.

● **A. J. Curtis & Company, P. O. Box 1072, Casper, Wyoming.** Has undetermined amount of ¾ to 6-in. city distribution line to lay for *Spokane Natural Gas Company*.

● **Engineering-Construction Company, First National Bank Building, Tulsa, Oklahoma.** Has contract with *Northwestern Public Service Company* to lay distribution systems in four towns in South Dakota, also has extensions in another South Dakota town. Field office has been set up in DeSmet; work started April 15.

● **Robert B. Somerville Company, 4891 Yonge Street, Toronto, Ontario.** Has 92 miles of 20-in. line to lay between Sarnia and Bright, Ontario for *Inter-Provincial Pipe Line Company*.

● **American Pipe Coating Contractors, Inc., P. O. Box 89, Jennings, Louisiana.** Has contract to clean and prime three miles of 8 and 12-in. line for *Tennessee Gas Transmission Company*. Also has 47½ miles of 3-in. line for *Magnolia Petroleum Company*. Has 6 miles of 4-in. for *Bell Oil Company*. Has 10½ miles of 12-in. line for *Gulf Interstate Gas Company*. Also has 17 miles of 12 and 16-in. gathering system for Anchor-Wate, Inc., (for *American Louisiana Pipe Line Company*).

● **Dutton-Williams Bros., Ltd., North Canadian Oils Building, Calgary, Alberta.** Has 320 miles of 10 through 4-in. distribution systems for *Inland Natural Gas Company* in Nelson, Savona, and Penticton, central British Columbia.

● **O. R. Burden Construction Corporation, P. O. Box 5216, Tulsa, Oklahoma.** Has 8 miles of 20-in. to take up in the vicinity of Roland, Arkansas, for *Magnolia Pipeline Company*. Has completed laying a similar amount of new line paralleling take-up job.

● **Dunn Bros., Inc., 801 Mercantile Securities Building, P. O. Box 5771, Dallas, Texas.** Has 105 miles of 34-in. for *El Paso Natural Gas Company* between St. Michaels and Navajo Station, Arizona. Has 145 miles of 34-in. line for *Western Pipe Line Company* east of Flagstaff to Topock, Arizona.

● **R. H. Fulton & Company, Inc., P. O. Box 1526, Lubbock, Texas.** Has 252 miles of 22-in. line for *Colorado Interstate Gas Company* between Rock Springs and Laramie, Wyoming. Has 78.4 miles of 26-in. line in the Minnesota section of *Interprovincial Pipe Line Company's* main line loop.

● **Latex Construction Company of Georgia, P. O. Box 184, Fond du Lac, Wisconsin.** Has 90 miles of 16 and 20-in. line between Oshkosh and Milwaukee, Wisconsin, for *Michigan-Wisconsin Pipe Line Company*.

● **Somerville Construction Company, Ada, Michigan.** Has 67 miles of 10 and 12-in. line from Clare County to Traverse City, Michigan, for *Michigan Consolidated Gas Company*. Also has 60 miles of 10 and 12-in. line between Muskegon and Ludington, Michigan, for the same company.

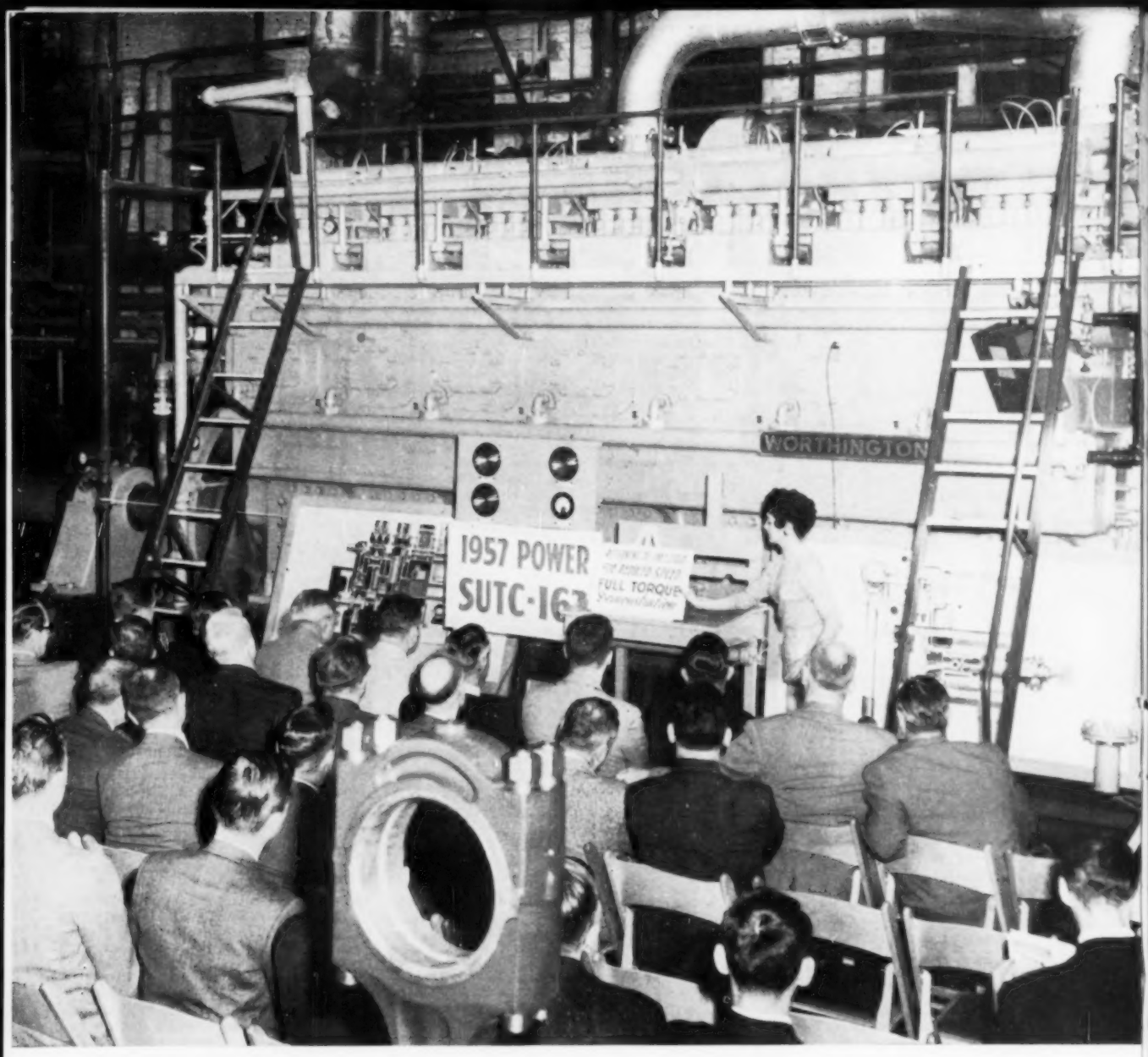
● **Williams Brothers Company, National Bank of Tulsa Bldg., Tulsa, Oklahoma.** Has 212.5 mile 20-in. crude line for *Socony Mobil Oil Company de Venezuela*. Line will extend from San Silvestre field to Puerto Cabello on the Caribbean Coast.

● **H. C. Price Company, Box 1111, Bartlesville, Oklahoma.** Has 71 miles of 30-in. line for *Texas Eastern Transmission Corporation* in the Port Lavaca, Texas, area.

● **Trojan Construction Company, Inc., 1416 N. Robinson, Oklahoma City 3, Oklahoma.** Has contract for takeup and reconditioning 276 miles of 8-in. line for *Sinclair Pipe Line Company* between Jacksboro and Mexia, Texas.

● **Eastern Pipeline Contractors, Mercantile Bank Bldg., Dallas, Texas.** Has contract for 89 miles of 6 and 8-in. line for *Gulf Refining Company*, from a point westward from Midland into New Mexico, near Hobbs.

● **Price-Poole Pipeline Constructors of Canada (joint venture of H. C. Price of Canada Limited and Poole Construction Company, Ltd., Rivers, Manitoba.** Has 99-mile section of 34-in. pipe to lay for *Trans-Canada Pipe Line Company* on a section of line in Manitoba Province extending eastward from the Assiniboine River near Miniota. Right of way has been cleared and limited activity is underway prior to actual construction beginning this spring as weather permits.



At 1957 Power Fair, engineers witness proof of...

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There's no better way to judge the performance of an engine than to see it in operation. That's why more than 250 process and pipeline engineers recently gathered in Buffalo, N. Y., to attend Worthington's 1957 "Power Fair."

Star of the show was the new SUTC TURBO-UNIFLO gas engine compressor. The only two-cycle engine compressor with exhaust powered turbocharging from start-up through full-load, the TURBO-UNIFLO features remarkable stability over the complete range of speed and load requirements.

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WORTHINGTON

Pipeline Projects

Transco to Add Stations in Texas and Louisiana

The Federal Power Commission has authorized Transcontinental Gas Pipe Line Corporation to construct and operate natural gas facilities in Texas and Louisiana at an estimated cost of $4,750,000.

The facilities authorized include the construction of an 880-hp Mission Valley booster station in Victoria County, Texas; an 880-hp booster station and dehydration plant in Luby field, Nueces County, Texas, and an 880-hp booster station, a dehydration plant, and a purchase meter in Greta field, Refugio County, Texas.

The authorization also includes the installation of an additional 3550 hp at Compressor Station No. 23 in Harris County, Texas; an additional 5000 hp at Compressor Station No. 24 in Beauregard Parish, Louisiana; 3.45 miles of 10-in. lateral supply pipeline in the Great field, and the construction of a 2200-hp compressor station in Nueces County, Texas.

Tennessee Gas Will Spend $187,000,000 if FPC Approves

Tennessee Gas Transmission Company has amended two applications which seek Federal Power Commission authorization for natural gas facilities that would increase its daily system delivery capacity by 571,701,000 cu ft.

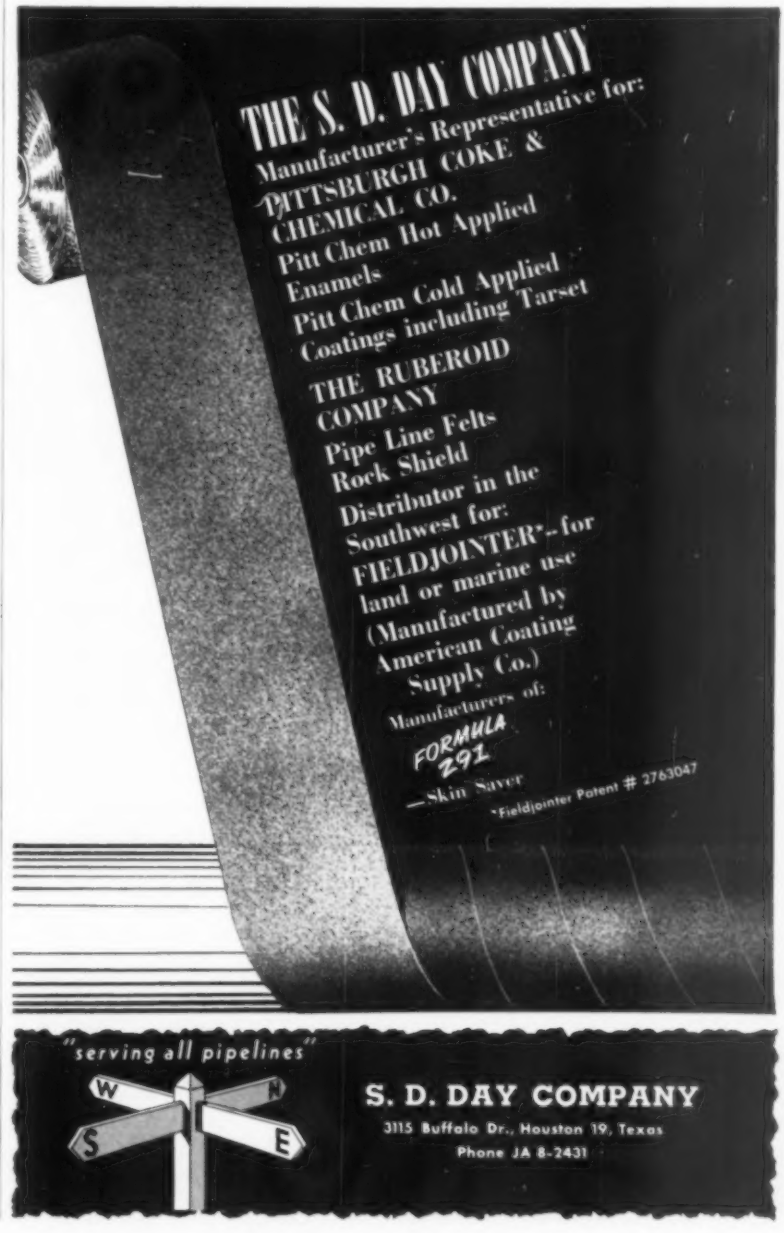
Tennessee said it was necessary to amend its applications to revise the sequence in which the proposed new facilities applied for in both dockets would be constructed and placed in service on its system in order to provide increased ability to render service to its present customers beginning in the fall of 1957.

Tennessee now proposes (Docket No. G-11, 107) to construct during the 1957 construction season, 175 miles of various diameter pipeline; 37,260 new and additional compressor horsepower in stations in Louisiana, Mississippi, Tennessee, and Kentucky; and a submarine crossing of the Mississippi River. These facilities would provide Tennessee with an additional average daily sales capacity of 118,137,000 cu ft. Estimated cost of the facilities is $39,740,000.

The second phase of Docket No. G-11,107, to be constructed during 1958, includes 896 miles of varying diameter pipe and 83,730 hp in new and existing compressor stations in Mississippi, Tennessee, New York, Pennsylvania, Kentucky, and Ohio at an estimated cost of about $135,366,000. These facilities would increase Tennessee's average daily delivery capacity by 338,271,000 cu ft.

In Docket No. G-9454, Tennessee proposes to construct facilities that would add 36,390 hp to new and existing compressor stations in Texas, Mississippi, Louisiana, and Tennessee. The estimated cost of the facilities is about $11,991,000. These facilities would provide Tennessee with the same increase in average daily capacity as originally proposed (115,293,000 cu ft). This would increase applicant's estimated peak day deliverability, including gas storage deliverability, to 2,886,076,000 cu ft.

Tennessee still proposes, as part of Docket No. G-9454, to sell up to 204,000,000 cu ft of natural gas per day to Midwestern Gas Transmission Company. All of the proposed facilities were contained in the original applications.



FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD D-99

Salt Lake to Expand Crude and Products Systems

Plans for a major expansion of both the crude oil line and products line systems of the Salt Lake Pipe Line Company are announced by P. N. Johnson, president.

Johnson said additional capacity of 14,000 bbl per day will be added to the Rangely, Colorado-Salt Lake City crude line by installing 100 miles of new 10-in. line and additional pumping facilities at existing pump stations. When complete, the crude oil line will be able to handle 70,000 bbl per day.

Capacity of the products line, which extends from Salt Lake City to Spokane, Washington, will be increased by 10,000 bbl per day between Salt Lake City and Boise, Idaho, by installing additional pumping facilities. In addition, the carrying capacity of the products line from Boise, Idaho, to Pasco, Washington, will be upped 5,000 bbl per day by installing 80 miles of new 8-in. line. When construction is completed the new throughputs will be 56,000 bbl per day from Salt Lake City and 30,000 bbl per day from Boise.

Pipe for both the crude and products line systems has been ordered and completion of the entire expansion is expected by the end of 1957.

Texas Eastern, Penn-Jersey Plan $30,000,000 Project

Texas Eastern Transmission Corporation and its wholly-owned subsidiary Texas Eastern Penn-Jersey Transmission Corporation, have filed applications with the Federal Power Commission requesting authorization for expansion projects that will add approximately 110,000,000 cu ft to the daily capacity of Texas Eastern's system.

Total cost of the project for both companies will be approximately $30,322,400, with the parent company's facilities costing some $25,904,600 and Penn-Jersey facilities about $4,417,800, according to Orville S. Carpenter, president of Texas Eastern.

The two applications request authority to add 67,610 hp of compression facilities and 137 miles of pipeline to Texas Eastern's system.

The compression facilities would include a new 10,250-hp compressor station near Mont Belvieu, Texas, on the company's recently authorized 30-in. pipeline from the Vidor compressor station near Beaumont, to a point on the Rio Grande near McAllen, Texas. The company would add horsepower on Texas Eastern's existing 30-in. line between Beaumont, Texas, and Kosciusko, Mississippi, as follows: 5200 hp at Gillis station, Beauregard Parish, Louisiana; 5280 hp at Opelousas station, St. Landy Parish, Louisiana; 5200 hp at St. Francisville station, West Feliciana Parish, Louisiana; 5280 hp at Union Church station, Jefferson County, Mississippi; 5200 hp at Clinton station, Hinds County, Mississippi, and 5000 hp at Kosciusko station, Attala County, Mississippi.

Texas Eastern also requested addition of approximately 2200 hp to a previously authorized station near Linden, New Jersey, and construction of metering and regulating stations.

Texas Eastern has asked the FPC for authorization to construct approximately 96.5 miles of additional 30-in. pipeline loops along the company's existing 30-in. line between Kosciusko, Mississippi, and Uniontown, Pennsylvania, and approximately 40 miles of new lateral supply lines.

The Penn-Jersey system requested authorization to construct and lease to Texas Eastern the following additions to existing or authorized compressor stations along its system: 4000 hp at Delmont station, Westmoreland County, Pennsylvania; 5000 hp at Lilly station, Cambria County, Pennsylvania; 5000 hp at Perulack station, Juniata County, Pennsylvania; 5000 hp at Grantville station, Dauphin County, Pennsylvania, and 5000 hp at Bechtelsville station, Berks County, Pennsylvania.

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Hearings May 14 on Midwest Gas Service

The Federal Power Commission has ordered consolidation of proceedings for hearings to begin May 14 in Washington, D. C., on 20 applications by nine pipeline companies, all relating directly or indirectly to natural gas service in the midwestern United States.

Three of the companies are proposing to build pipeline projects that are competitive with facilities proposed by Midwestern Gas Transmission Company, of Houston, Texas. The three companies are Michigan Wisconsin Pipe Line Company, of Detroit, Michigan; Northern Natural Gas Company, of Omaha, Nebraska, and Natural Gas Pipeline Company of America, of Chicago, Illinois.

Applications of five other companies are affected by the order. These are American Louisiana Pipe Line Company of Detroit; El Paso Natural Gas Company of El Paso, Texas; Permian Basin Pipeline Company of Omaha; Iron Ranges Natural Gas Company of St. Paul, Minnesota, and Tennessee Gas Transmission Company of Houston.

American Louisiana supplies gas to Michigan Wisconsin; El Paso and Permian both are proposing to build facilities relating to Northern Natural's gas supply; Iron Ranges is seeking authority to build a pipeline project in Minnesota with gas to be supplied either by Midwestern or Northern; and Tennessee would supply half of Midwestern's gas supply, with the other half coming from Canadian sources.

Midwestern is proposing to build a pipeline system from the Portland, Tennessee, area to the U. S. Canadian border where it would receive 204,000,000 cu ft of natural gas per day from Trans-Canada Pipe Lines, Ltd., near Emerson, Manitoba. Another 204,000,000 cu ft would be purchased from Tennessee Gas Transmission at the Portland connection. Midwestern would serve customers in North Dakato, Minnesota, Wisconsin, Michigan, Illinois, and Indiana.

Michigan Wisconsin is seeking authority to construct facilities to serve communities in Michigan and Wisconsin, some of which are in areas proposed to be served by Midwestern. The FPC previously had reserved permanent allocation of 61,385,000 cu ft of gas per day from American Louisiana's system for potential delivery to Michigan Wisconsin in these competitive areas.

Northern Natural's pending applications involve proposed service to Iron Ranges, and to 192 communities in Iowa, Nebraska, Minnesota, and Wisconsin, 39 of which are also proposed to be served by Midwestern.

Permian Basin is proposing to construct facilities to supply gas to Northern, with delivery to be made by Permian to El Paso for redelivery to Northern. El Paso would build facilities to enable it to transport and deliver this and other gas to Northern.

Iron Ranges would construct a pipeline in Minnesota to serve numerous cities and villages, with Midwestern and Northern each proposing to supply the necessary gas.

Construction of Products Line Begins in July

Trust Pipe Line Company, subsidiary of Cosden Petroleum Company of Big Spring, Texas, will begin work in July on a 6-in. 128-mile products line from Abilene and Wichita Falls.

A terminal will be constructed at Wichita Falls, the site for which has been purchased.

Supplying the line will be the Cosden refinery at Big Spring, the Hawley (formerly Onyx) refinery north of Abilene, and the Col-Tex plant at Colorado City. Short laterals will supply two air force bases.

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D-101

Plans for Kansas Crude Lines Revised

Southern Kansas Pipe Line Company, which originally announced a 6 and 10-in. pipeline from Liberal to Arkansas Ctiy, Kansas, has advised the Kansas Corporation Commission of revised plans. What would have been a 240-mile line with capacity of 10,000 bbl a day, will now be extended to the Greenwood pool near the Colorado line and capacity possibly increased.

Promoters of the line are Alladin Petroleum Company, Wichita, and Anderson-Prichard Oil Corporation, Oklahoma City, which owns a refinery in Arkansas City.

New plans also may include a gathering system in Oklahoma Panhandle fields. Products in the Oklahoma Panhandle and southwestern Kansas recently lost their limited market due to discontinuance of purchasing and trucking by the Groendyke Petroleum Company, which has been making deliveries to Shamrock Oil and Gas.

Yellowstone Laying Jet Fuel Line to Air Bases

A jet fuel pipeline, extending 25 miles from the Spokane, Washington, delivery facilities of Yellowstone Pipe Line Company in the East Spokane area to the Geiger and Fairchild Air Force Bases, has been announced by R. E. Lombard, superintendent of Yellowstone.

The 8-in. jet fuel line will be an extension of the 540-mile Yellowstone line from Billings, Montana, to Spokane. Continental Oil Company and Carter Oil Company each have a 40 percent interest in the Yellowstone line. Other owners are Union Oil Company of California, 14 percent, and H. Earl Clack, Inc., 6 percent.

Engineers Limited Pipeline, San Francisco and Seattle, has been awarded the contract to build the line, which will be constructed under the supervision of Yellowstone Pipe Line Company engineers.

Products System Given Rapid Write-off by ODM

A rapid tax write-off certificate has been granted by the Office of Defense Mobilization to Underground Storage and Exploration, Inc., for construction of a products pipeline in the East. The 393-mile system would extend from Moundsville, West Virginia, to Newark, New Jersey, with laterals to Mauch Chunk, Marcus Hook, and Philadelphia.

A spokesman for Underground Storage and Exploration said the line would be supplied by Texas Eastern Transmission Corporation, if that company is allowed to convert the "Little Inch" line, or American Pipe Line Corporation (Paul Ryan), if that line should be built.

Proposed plans are for a 12-in. line between Moundsville and Newark, with the laterals 6 and 8-in. Capacity would be 125,000 bbl a day.

Two underground storage cavities are planned, one for 300,000 bbl at Moundsville, the other for 12,000,000 bbl at Mauch Chunk.

E. J. Tempest, Upper Darby, Pennsylvania, was listed as the party of interest on the ODM application. Representative in Washington, D. C., was given as Bernard J. Long, Pennsylvania Building.

Permian Basin-Houston Crude Line Announced

A 26-in. crude oil line from the Midland, Texas, area to Houston has been announced by seven major producers in the Permian Basin, with completion planned for the spring of 1958.

Participants in the new pipeline are Atlantic Refining Company, Cities Service Oil Company, Continental Oil Company, Gulf Oil Corporation, Phillips Petroleum Company, Sinclair Oil and Gas Company, and The Texas Company.

Capacity of the system will be between 400,000 and 500,000 bbl a day, depending on the number of pump stations decided upon.

Oil Line From Williston Considered by Railroad

Great Northern Railway is considering the feasibility of a pipeline originating in the Williston Basin, which enbraces western North Dakota and eastern Montana, John M. Budd, president, has announced. The pipeline would transport crude oil to the St. Paul-Minnesota and Duluth-Superior areas.

Pipe Line Technologists, Inc., of Houston, Texas, has been retained by Great Northern to assist in the studies, which still are in the preliminary stage.

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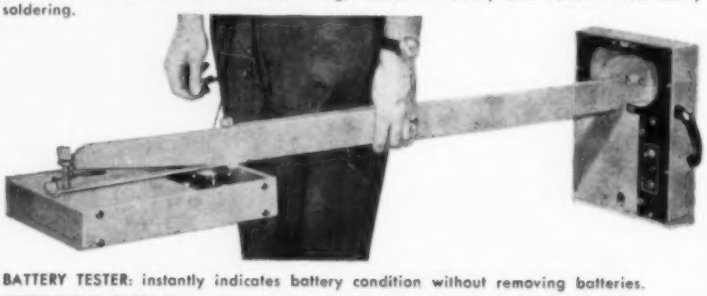
Spots all sub surface pipes, cables, etc., and determines their depth accurately.

ETCHED CIRCUITRY: instead of hand wiring, insures uniformity and freedom from faulty soldering.



BATTERY TESTER: instantly indicates battery condition without removing batteries.

INSTRUMENT CASE: Made of tough, wear resisting phenolic material. The antennas are an integral part of cases, moisture and shock proof.

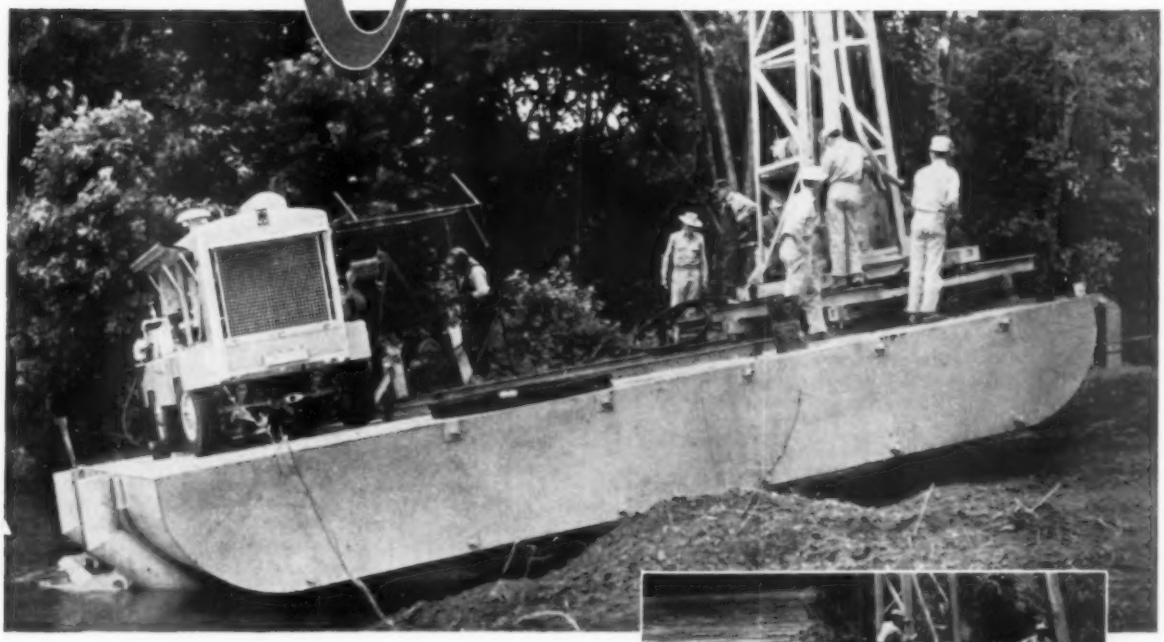
WILKINSON PRODUCTS COMPANY

3987 Chevy Chase Drive, PASADENA 3, CALIFORNIA. SYlvan 0-4314

30" PIPELINE CROSSES POTOMAC

with the aid of a drill-barge-mounted

GYRO-FLO PORTABLE



Unique submarine drill barge, built by Associated Pipe Line Contractors, Inc., is powered by a standard Ingersoll-Rand 600 cfm Gyro-Flo portable compressor

Associated Pipe Line Contractors, Inc., recently completed laying a 30" line across the Potomac River near Rockville, Md. The river at this point was 2800 feet wide with a bed of solid rock.

This difficult rock drilling problem was solved by using the all-steel drill barge shown above, built by Associated. On it are mounted an Ingersoll-Rand SD-65 Submarine Drill which is powered by a 600 cfm Gyro-Flo portable air compressor. The Gyro-Flo is anchored aboard without removing the running gear, thus leaving it available for on-land drilling work.

This river crossing is a part of Associated's 80 mile section of Transcontinental Pipe Line Corporation's main line looping program from Texas to New York. The Gyro-Flo mounted on the barge was only one of a number used on this project, and these compressors, together with other Ingersoll-Rand rock drilling equipment gave their traditional trouble-free performance.

Wherever contractors need dependable, low-cost air power, they agree that "there's only *one* Gyro-Flo". Ask your Ingersoll-Rand representative to give you the complete story.

Ingersoll-Rand

2-396

11 Broadway, New York 4, New York

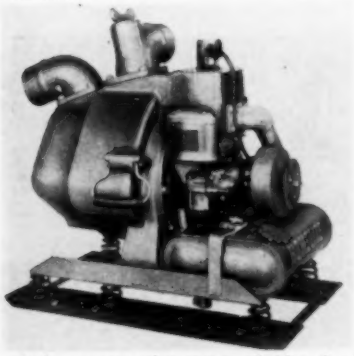
AN UNBEATABLE COMBINATION ... GYRO-FLO COMPRESSORS AND I-R ROCK DRILLS

NEW Pipeline Equipment

• machinery • supplies • services

For more information on items described here in brief, use the handy reply card and circle the corresponding numbers

Centrifugal Pressure Pump. Homelite Model 24S3-1P is a centrifugal pressure pump designed specifically for fire departments, contractors, utilities, and general industries.

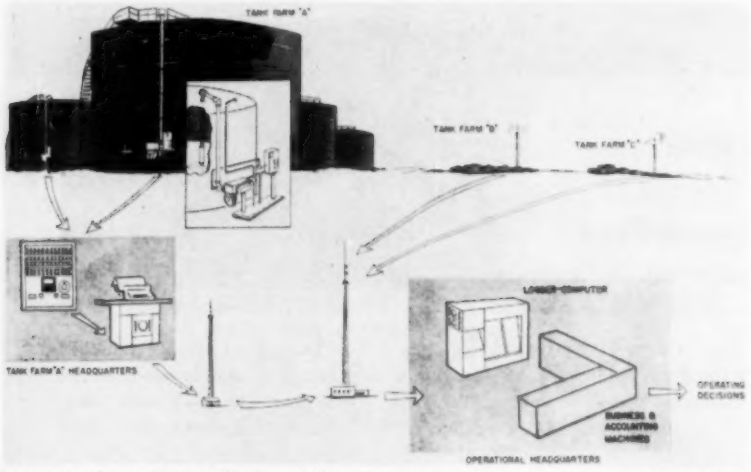


It has a capacity range of 55 gal of water per min at 70 lb pressure to 205 gal of water per min at open discharge. Weighing only 107 lb, unit is easily carried to any location. Closed-type impeller is designed with large clearances to permit operation in muddy water and constructed of long-wearing cast iron for long service life. *Homelite, a division of Textron, Inc.*

Circle number (81) on reply card.

Automatic Shut-Off Valve. Automatic shut-off valve has 3 new basic features in design, which provide better control of the oil level in tanks and prevent air from entering the pipeline. Value is a diaphragm actuated balanced valve operating on tank pressure differential. Upstream tank head is the only factor that controls the opening and closing of valve. Two spring-loaded rotating toggles hold the valve open; then as the liquid level in the tank drops, toggles snap the valve closed. *W. L. Walker Company.*

Circle number (82) on reply card.

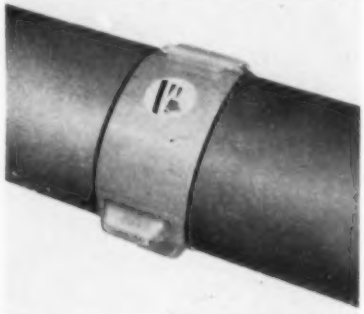


Electronic Tank Gaging System. Gilbert & Barker Mfg. and Fischer & Porter Co. have combined equipment for complete tank gaging and data handling systems. Signals from many gages may be programmed through these systems, telemetered to distant central headquarters, and there presented on typewritten log sheets, punched paper tape, punched accounting cards, and other digital output devices. Fischer & Porter plans development of an integrated data processing system capable of tying multiple tank farm installations together on a nationwide basis for purposes of inventory control.

The Gilbarco gage uses a highly-sensitive, servo-operated probe to detect the absolute liquid level in a tank. Minute, high frequency signals, whose phase and magnitude are determined by the probe's contact with the liquid, automatically raise and lower the sensing element to accurately follow the changes in liquid level. Data may be logged at local offices for production scheduling and operating guides, and simultaneously telemetered to the company's main office for top management analysis. This then permits the utilization of a digital computer, thus coordinating marketing and economic factors with the latest product inventory. *Fischer & Porter Company and Gilbert & Barker Mfg. Co.*

Circle number (83) on reply card.

Rugged Insulator for Big-Inch. "Steel Clad" insulator for big-inch pipelines in oversize casings under highways and railroads is available for all pipelines 16 in. and larger. Design features of this heavy duty insulator include hollow forged steel runners machine welded to a one-piece



flexible steel band. Test load 92,550 lb per runner. The exclusive sling joint prevents the butt edges of the band from digging into the pipe coating, and a thick insulating liner of oil-resistant rubber secured to the high-tensile steel band provides positive insulation. *T. D. Williamson, Inc*

Circle number (84) on reply card.

Heavy Duty Ripping. Model R-89 Ripper for use in heavy duty ripping, to be attached to bulldozers 43 to 60-in. high in the 150 to 320 hp tractor range, has been introduced. It features the one man rack and pinion depth adjustment and has a 4 by 7-in. ripping shank with a new 28 lb cast manganese tooth. *The Ransome Corporation.*

Circle number (85) on reply card.

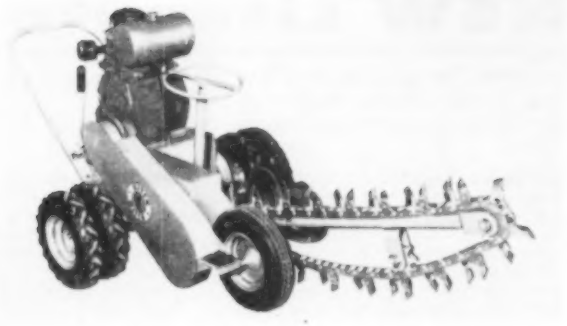
New Compressor Valve for Air and Gas. A new concept in compressor valve design has been introduced by the Ball Valve Company. Designated the BV valve, it uses the ball check valve principle instead of the plate valve technique widely used at this time. Design uses a multitude of spring-loaded check valves built into the valve body. Advantages to the petroleum industry indicated by manufacturer are simplicity of design; streamline flow

for greater valve efficiency; reliability in that instantaneous failures can not occur; and lower maintenance costs due to ease in reconditioning of valve and greater valve life. Valves are designed for use in compressors in the refining, gas processing, and gas transmission industries as well as air and gas drilling. *The Ball Valve Company.*

Circle number (86) on reply card.

Horizon Camera. A 360° horizon camera for recording vertical and horizontal images on 35 mm film has been announced. Camera is used for making horizon profiles to predict radar or microwave patterns in an area, or for plane table work. Weighing about 20 lb and mounted on a surveyor's standard tripod, the instrument incorporates a precise level line and is designed to permit very accurate measurement of azimuth angles. Set up and leveling for the horizon camera follows the same routines as setting up a surveyor's level. The camera turns through its 360° arc in approximately 1 minute. Film capacity is approximately 400 ft, sufficient to survey about 60 sites. Top left. *Aero Service Corporation.*

Circle number (87) on reply card.



Low Cost Trencher. Low cost service line trencher for contractors, utility companies and municipalities has been announced. New Model M Ditch-Witch trencher is completely mobile with 3 forward digging speeds and reverse. In usual digging conditions the Model M will trench at speeds of 1½ to 6 ft per min. Unit is suited for digging service lines: Gas, LP-gas, water; and cathodic protection: Ditches or pipelines. Powered by an 8 hp air cooled engine, unit weighs 500 lb. Top right. *The Charles Machine Works Inc.*

Circle number (88) on reply card.

Cutting Non-Ferrous Metal Plate. Inert gas welding process is now being used for cutting non-ferrous metals in addition to welding ferrous and non-ferrous metals.

Using standard equipment, this new process requires no special operator techniques. Simple adjustments in gas flow

and steel wire speed are all that are needed. Both high-production machine equipment and manual equipment can be adjusted for cutting with equal facility. Aluminum, stainless steel, chrome steel, nickel, monel, inconel, copper, brass, and aluminum bronze have been cut satisfactorily by subsequent welding operations. *Air Reduction Sales Company.*

Circle number (89) on reply card.

When Overloads *STRIKE*
Gas Transmission or
Distribution Line Scrubbers . . .

. . . Aerotec Dry Gas Scrubbers easily handle it without loss of efficiency.

Up to 100% overload can be handled by Aerotec Gas Scrubbers while still maintaining normal efficiency. Some of the features which contribute to the wide acceptance of these unique and outstanding scrubbers are:

Delivery of gas, free from dust and liquid carryover.

Small size for equivalent volumes as compared to conventional types.

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Project Engineers **THE THERMIX CORPORATION** Greenwich, Conn.
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THE AEROTEC CORPORATION
Greenwich, Conn.

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD D-105

NEW Literature

For more information on items described here in brief, use the handy reply card and circle the corresponding numbers

Fascinating Numbers. The Graham Computer and booklet "Fascination in Numbers" is offered to readers by Graham Transmissions Inc. A unique computer, it can be applied to ordinary slide rule calculations as well as special business problems. Designed for horsepower calculation, the calculator has been used in calculating the volume of tanks. For instance, for a formula for capacity of a tank in gallons in terms of tank diameter and length, the special vertical scale for diameter at the left would have markings on each side and would include the diameter square and the constant, and the standard horizontal scale at the bottom would set the length—the capacity being read on the diagonal. *Graham Transmissions Inc.*

Circle number (90) on reply card.

Differential Pressure Sensing Unit. Barton Instrument Corporation has published a bulletin, No. 224-1, describing the Barton Differential Pressure Sensing Unit, Model 224. It includes an explanation of construction and operating principle, bellows, torque tube, range springs, self-venting and self-draining, and mounting. This bulletin also shows models of the company's pneumatic indicating transmitter, indicators, differential pressure recorder, and indicating flow switch. *Barton Instrument Corporation.*

Circle number (91) on reply card.

Wire Rope. By means of photographs and drawings with reeving diagrams, a new brochure lists the proper wire rope specification for all types of construction equipment. Included is a discussion of Lang Lay vs Regular Lay rope, rope constructions and proper wire rope to use for clamshell bucket operation. Called "The Correct Wire Rope for Contractors' Equipment," brochure is No. 5702. *Macwhyte Company.*

Circle number (92) on reply card.

Conduit for Underground Piping. This 12-page color publication covers all the essentials pertaining to underground pipe conduit. It shows how Thermo-O-Tile is constructed and installed with both molded and filler insulation. How the piping is supported, anchored, and guided is discussed. Arch diameters, base sizes, and double conduits for multiple pipes too large for a single conduit are included. *The Porter-Hayden Companies.*

Circle number (93) on reply card.

IH TD-24 Mailer. International Harvester Company has made available an 8-page, 2-color mailer on the 200 hp TD-24, largest in the IH crawler line of 7 units. Entitled "Boss Of The Big Jobs," the pamphlet emphasizes the solid framework of the unit, planet power steering, and the option of torque converter or gear drives. Line drawings illustrate components of the torque converter drive system, the main frame, and a cutaway exposure and explanation of the planet power steering system. *International Harvester Co., Construction Equipment Division.*

Circle number (94) on reply card.

Basic Sediment & Water Monitor. A 4-page, color brochure has been announced by Instruments, Inc. on Gulf Research and Development Company's BS&W Monitor for measuring and controlling the bs&w content of crude oil at automatic custody transfer installations. A photo, diagram, and charts describe the monitor, how it operates, and a typical installation. *Instruments, Inc.*

Circle number (95) on reply card.

Graduate Training Program Reprint. Allis-Chalmers graduate training program is the subject of an 8-page reprint entitled "The Guided Self-Development of Engineers." It sets forth how the program helps the engineering graduate find his place in industry and how it augments his academic training. Emphasis is on the engineering technical course, one of 7 part-time courses offered, because it exemplifies the underlying philosophy of engineering training within the company. *Allis-Chalmers Manufacturing Company.*

Circle number (96) on reply card.

Protective Coating Catalog. A new 25-page, 2-color Polyken Protective Coatings Catalog gives full information on protective tape coatings. Nature of corrosion and its control is discussed and advantages of wrapping with Polyken polyethlylene tape are shown by diagrams, drawings and descriptive copy. The tape method of application to pipe is fully explained — preparation of surfaces, how they are coated, and inspected. Case histories of successful applications of the Polyken method are cited. An additional section concerns specifications, surface preparations, taping and wrapping, inspecting, repair, and special wraps for welded pipe. Smaller, less common applications are also explained. *The Kendall Company, Polyken Sales Division.*

Circle number (97) on reply card.

Catalog on Fans. A revised catalog, Bulletin A-111B, covering adjustable-pitch cooling tower and heat exchanger fans has been published by Hartzell Propeller Fan. Catalog contains descriptions, specifications and performance data on fans with aluminum-alloy blades in diameters from 40 to 132 in. and models with Hartzite plastic blades in diameters from 10 to 22 ft. It also includes detailed data on the Hartzell controllable-pitch heat exchanger fan. *Hartzell Propeller Fan Company.*

Circle number (98) on reply card.

Ramco Master Catalog. A new 96-page master Ramco catalog for use by installers and specifiers of piston rings for cars, trucks, tractors, buses, stationary engines, and light-weight 2 and 4-cycle engines has been announced. Catalog lists Ramco engineers' recommendations for 10-Up sets utilizing full chrome, partial chrome, cast-iron and steel ring combinations as required to best meet the conditions of each engine design. New edition has been simplified in listing arrangement. *Ramsey Corporation.*

Circle number (99) on reply card.

New Book on R/M Poly-V Drive. A completely new 112-page Engineering Data Book for the selection and design of Poly-V Drives has been announced. The book contains many charts, tables, and diagrams along with complete specifications for all drive sizes. Selection of proper Poly-V Belts and Sheaves for drives of any speed or horsepower rating is made possible, without calculation, by means of the complete, easy-to-use standard drive tables. The book provides complete coverage of both theory and the practical application of the new R/M Poly-V Drive, along with numerous illustrated case histories. In addition, comprehensive data on V-belt drives is included, covering drive tables, horsepower ratings, installation instructions and trouble shooting. *Manhattan Rubber Division, Raybestos-Manhattan, Inc.*

Circle number (100) on reply card.

Free Check List Brochure. Stepped-up production in the plant almost always means stepped-up activity in the drafting room. One way to pinpoint possible increases in productivity is to go, item by item, through a check-up-list showing every type of product used in a modern, well-equipped drafting room. Such a list, covering equipment and supplies from A to Z and suggesting several specific ways to cut down waste motion, eliminate time-consuming methods, reduce fatigue, save space, etc., is available. *Frederick Post Company.*

Circle number (101) on reply card.

X-Tru-Coat. A 4-page folder on Republic's new X-Tru-Coat plastic-coated steel pipe and tubing has just been published. Folder describes the problems of pipeline corrosion, and shows how the strength of steel and the protection of plastic have been combined in a product to meet the requirements of the most severe corrosive applications. *Republic Steel Corporation.*

Circle number (102) on reply card.

Liquid-Gas Separation Device. A new bulletin, "Liquid-Gas Separation," has been published describing the Selas Liqui-Jector, a liquid-gas separation device for removal of entrained liquids and solids from air, gas and steam systems. Liqui-Jector completely removes suspended liquid and solid particles from process and instrument gas supply lines. Available in 3 standard models for volumes up to 7000 scfm and pressures to 200 psig, and specially-engineered units for unusual applications. *Selas Corporation of America.*

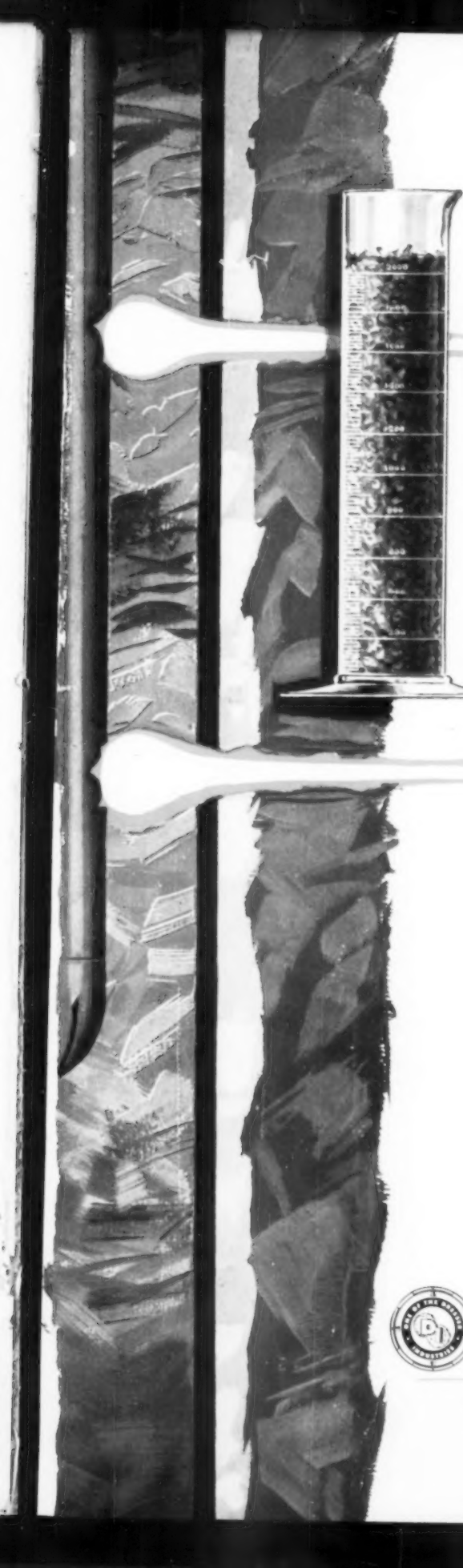
Circle number (103) on reply card.

Welding Wire. Bulletin DH-402A describes the many Page methods of packaging welding wire, including their newest innovation—Payoffpaks. It also gives complete and up-to-date analyses of the various Page stainless steel, low alloy, and carbon steel welding wires. *Page Steel and Wire Division, American Chain and Cable Company, Inc.*

Circle number (104) on reply card.

Ovaloid Tanks. R. D. Cole Mfg. Co. has announced a new bulletin on ovaloid tanks. This bulletin includes pictures of tanks used in cities over the country, their capacity, dimensions and average cubic yards at foundation. *R. D. Cole Mfg. Co.*

Circle number (105) on reply card.



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AND HERE'S WHY! All shaped-charges make debris — but only Lane-Wells Karrotfree Koneshot keeps the debris in the gun to give you cleaner, deeper holes. And . . . in test after test, Karrotfree Koneshot consistently blasted deeper into the formation attaining a significant 14% greater penetration than any other 4-inch shaped-charge gun available today. Only Lane-Wells Karrotfree Koneshot gives you both deep penetration and debris-free perforations. Formation plugging carrots and charge debris that were "trapped" in a Karrotfree Koneshot gun and removed from the well out of the way of full production are shown in this illustration.

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